Issued January 1967

SOIL SURVEY

Judith Basin Area
Montana

This is the last soil survey of the 1959 series

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
and Forest Service
In cooperation with
MONTANA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of the Judith Basin Area contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Identifying the Soils

All the soils of the Judith Basin Area are shown on the detailed map at the back of this report. This map has many sheets made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets. This index helps to locate an area quickly on the detailed map.

On each sheet of the detailed map, soil boundaries are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Recording Information

Use the "Guide to Mapping Units" to find information in the report. This guide lists all the soils of the Judith Basin Area in alphabetic order by map symbol. It shows the page where each soil is described, and also the page for the capability unit, range site, and windbreak suitability group in which the soil has been placed.

A good way to learn about the soils on a farm or other tract, and their capabilities is first to list the symbols shown on the soil map for the tract, and then to refer to the "Guide" for the names of the soils and the groups in which each soil has been placed. Read about the soils in the pages given in the "Guide." Colored sketch maps can be prepared to record decisions made after the parts of the report designated on the "Guide" have been studied. Trace the boundaries of the soils on transparent paper or plastic laid over the detailed soil map. Then color the soil areas to show their degree of limitation when used for crops, pasture, trees, septic tanks, parks, playgrounds, or many other purposes. Green, for example, can indicate soils with *slight* limitations; yellow, *moderate;* and red, *severe.*

Farmers and those who work with farmers can learn about the use of the soils for agriculture mainly in the descriptions of the soils and in the discussions of the capability units.

Foresters and others interested in woodland can refer to the subsection "Use of Soils as Woodland and in Windbreaks." In that subsection the soils of the Judith Basin Area are placed in groups according to their suitability for trees, and management of each group is discussed.

Game managers, sportsmen, and others concerned with wildlife will find information about the main kinds of wildlife and their food and cover in the subsection "Wildlife Management."

Ranchers and others interested in range will find, in the subsection "Use and Management of Soils for Range," that the soils of this survey area are grouped according to their suitability for range, and that the management of each group is discussed.

Engineers and builders will find, in the subsection "Engineering Uses of Soils," tables that give engineering descriptions of the soils of the survey area; that name the soil features affecting engineering practices and structures; and that rate the soils according to their suitability for several kinds of engineering work.

Scientists and others who are interested can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in the Judith Basin Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Survey Area," which gives additional information about the survey area.

* * * * *

This survey is the cooperative work of the Soil Conservation Service and the Forest Service, United States Department of Agriculture, with the Montana Agricultural Experiment Station. Fieldwork was completed in 1959. Unless otherwise indicated, all statements in this report refer to conditions in the Judith Basin Area at the time the survey was in progress.

Cover picture: The agriculture of the Judith Basin Area is based mostly on grain and livestock. (Photograph courtesy of Calder's Exclusive Aerial Murals, Lewistown, Mont.)

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402

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SOIL SURVEY OF JUDITH BASIN AREA, MONTANA

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE MONTANA AGRICULTURAL EXPERIMENT STATION

THE JUDITH BASIN AREA, or the area covered by this soil survey, consists of Judith Basin County except that part within the Lewis and Clark National Forest in the southwestern part of the county (fig. 1). The survey area amounts to 897,980 acres, or about 1,403 square miles. One-third of this area is cropland, and the rest is rangeland or woodland. Wheat is the main crop, but livestock is also important.

Farmers and ranchers organized the Judith Basin County Soil Conservation District in 1948. The District helps farmers and ranchers get technical assistance in soil and water conservation from the United States Department of Agriculture. This soil survey is a part of that assistance.

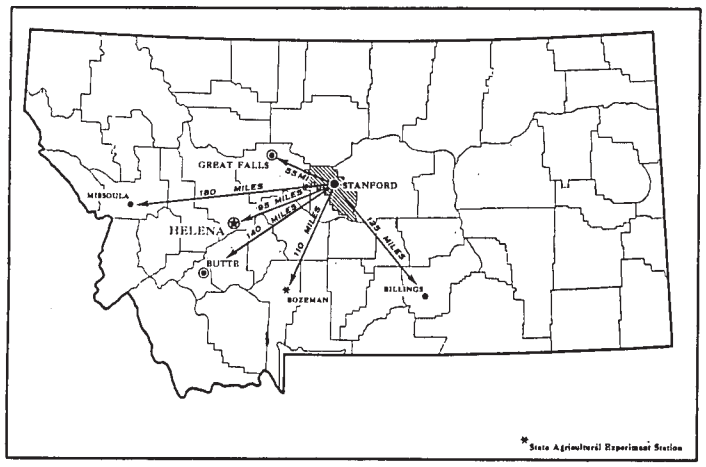

Figure 1.—**Location of Judith Basin Area in Montana.**

How Soils Are Mapped and Classified

Soil scientists made this survey to learn what kinds of soils are in the Judith Basin Area, where they are located, and how they can be used.

They went into the survey area knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the survey area, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Danvers and Twin Creek, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristics that affect use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Twin Creek loam and Twin Creek clay loam are two soil types in the Twin Creek series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Twin Creek loam, 2 to 4 percent slopes, is one of several phases of Twin Creek loam, a soil type in this survey area that has a slope range of 2 to 15 percent.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Sapphire-Cheadle complex. Two or more recognized soils that are not regularly associated geographically may be mapped together as an undifferentiated soil group, if the landscape is such that separating them is impractical. Such a group in this survey area is Judith and Raynesford stony loams. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on the soil map like other mapping units, but they are given descriptive names, such as Loamy alluvial land or Wet land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and their laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils called soil associations. Such a map is the general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform.

The soils within any one association are likely to differ from each other in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but patterns of soils in each of which there are several different kinds of soils.

Each soil association is named for the major soil series in it, but as already noted, soils of other series may also be present. The major soils of one association may also be present in another association, but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

Most of the 14 soil associations in the survey area consist mainly of loamy soils. The soils in association 3 are loamy and occur on bottoms and low terraces. Soil associations 1, 2, and 4 are on high benches and consist of loamy, gravelly, and clayey soils. Soil associations 6, 7, 8, 9, and 14 are on uplands and consist of soils that are generally loamy but are clayey or channery in some places. In soil associations 10, 11, and 12 are loamy, forested, and grass-covered soils on mountain slopes. The soils in association 13 are stony and nonstony loams on foothills. In soil association 5 are shallow clays in rough, broken topography. Each of these soil associations is described in the following pages.

1. Danvers-Judith association: Deep and moderately deep, loamy soils over very gravelly material on nearly level and gently sloping high benches

This is the most extensive soil association in the survey area. It occupies the nearly level and gently sloping, noncontiguous high outwash benches in the plains section of the survey area (fig. 2). At Moccasin, in this association, is a branch of the Montana Agricultural Experiment Station. The soils developed in alluvium under a dense cover of mid grasses and are dark colored and well drained.

The Danvers soils, as a rule, occur in the more nearly level areas and have a dark-colored surface layer 4 to 6 inches thick. Their subsoil is firm, grayish-brown heavy clay loam with blocky structure. It is underlain by light-colored, strongly calcareous clay loam that merges with very gravelly material at an average depth of about 30 inches.

The Judith soils generally occupy the gentle slopes and rises and the outer fringe areas of the benches. Immediately beneath their dark-colored surface layer is a very light colored, strongly calcareous subsoil that merges with very gravelly material at a moderate depth. The Judith soils lack the firm, grayish-brown subsoil that occurs in the Danvers soils.

The Danvers soils make up about 50 percent of the entire association, and the Judith soils, about 40 percent, but the proportion of these soils varies considerably in a few areas. For example, the small areas between the Highwood Mountains and Arrow Creek are nearly 80 percent Danvers soils, and the southwestern parts of most of the other areas are dominantly Judith soils that, to the northeast, grade to Danvers soils within short distances. Toward the northeast, therefore, the proportion of Danvers soils generally increases.

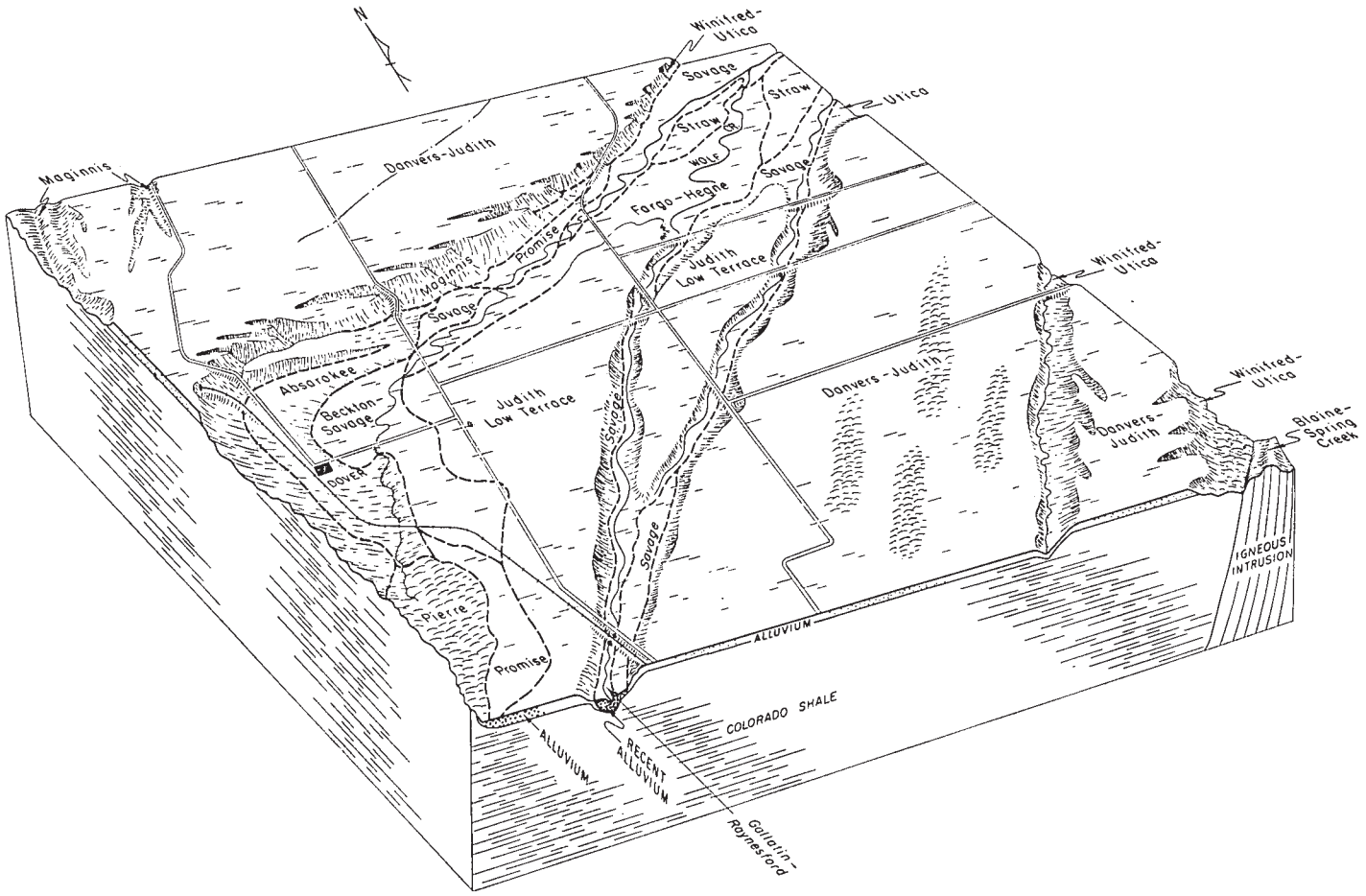

Figure 2.—**Typical pattern of soils in the Danvers-Judith association.**

Small areas of Winifred and Utica soils account for most of the remaining 10 percent of the association. The Utica soils are gravelly loams that occur on steep edges of benches and have a thin surface layer. The Winifred soils occur on short foot slopes below the Utica soils and have a dark surface layer and a grayish-brown, blocky heavy clay loam subsoil. Shale underlies the Winifred soils at a depth of 2 to 4 feet.

Most of this association is used to produce small grain, mostly wheat. Yields ordinarily are good. Winter wheat is more extensive than spring wheat, and some barley is grown. Most of the wheat farms of the survey area are on this association, as well as parts of combination wheat and livestock ranches that extend from other associations. Small acreages are used for tame pasture and for hay. The growing season is too short for corn grown for grain to mature, but corn can be successfully grown for fodder and silage. Because rainfall is limited, conserving moisture and controlling wind erosion are the main problems.

2. Winifred-Utica association: Deep and moderately deep clay loams over shale on rolling uplands and thin, very gravelly soils on steep edges of benches

This association occupies rolling uplands that are thinly mantled with alluvium. It is below and adjoining the high benches in the plains section of the survey area. Slopes range from moderate to steep. The soils in this association developed under a dense cover consisting mainly of mid grasses.

The Winifred soils account for 50 percent of this association and are dominant, though the soils of several other series also occur. Winifred soils are in rolling areas below the steep crests of the benches. They have a dark surface layer and a grayish-brown, blocky subsoil. The subsoil merges with the underlying shale at a depth of 2 to 4 feet.

The Utica soils are prominent in the landscape, for they occur on the steep crests of benches that border the rolling areas and, to a lesser extent, on steep remnants of benches within those areas. The Utica soils have a thin, dark surface layer and are very gravelly throughout. They amount to slightly more than 15 percent of the association.

Also in the association are Promise, Pierre, and Danvers soils. The Promise soils—deep, granular clays on moderately steep slopes—occupy slightly less than 15 percent of the association. Pierre soils are steep and moderately steep and consist of granular clay that is moderately deep over shale. They amount to about 5 percent of the association. The Danvers soils have a dark-colored surface layer and a grayish-brown, blocky upper subsoil. Their light-colored, strongly calcareous lower subsoil merges, at a

depth of about 30 inches, with pebbles mixed with material finer than sand. Danvers soils make up about 5 percent of the association.

The remaining 10 percent is made up of Savage, Absarokee, and Maginnis soils and soils that occur on gently sloping fans and have a thin or moderately thick claypan and barren, salty spots. The Savage soils occur on fans and terraces and have a dark surface layer and a moderately thick, grayish-brown subsoil that grades to deep, calcareous material. The Absarokee soils and the Maginnis soils are on moderate to steep slopes, but the Absarokee soils are moderately deep, and the Maginnis soils are shallow over stratified shale and sandstone.

A large part of this association is too steep for cultivation. About 50 percent is in native range and pasture, and the rest is used to produce small grain and hay. Crop yields are good on the Winifred, Promise, Danvers, and Savage soils. The association, therefore, is well suited to a grain-livestock type of agriculture. Farms and ranches range from about 660 to 3,800 acres in size, but the average size is about 1,400 acres. Because much of this association is rough, sloping, and dissected by drains, the tillable fields are smaller than those on high benches in soil association 1. Rainfall is limited, but soils that are not too steep for cultivation are deep and have good capacity for storing moisture. In most areas that can be tilled, runoff is medium to moderately rapid. On cropland, therefore, the main problems of management are conserving moisture and controlling water and wind erosion. On rangeland the main problem is to keep or establish a cover of the most desirable and productive range plants.

3. Savage-Straw-Gallatin association: Deep, well-drained to imperfectly drained, loamy soils on nearly level and gently sloping bottoms and low terraces

This association occupies the bottoms and terraces that range from ⅛ mile to 2 miles in width and occur along the major streams of the plains and lower foothills. The soils are mainly well-drained to imperfectly drained clay loams.

The Savage soils typically have a dark-colored silty clay loam surface layer 4 to 6 inches thick. Their subsoil is firm, grayish-brown silty clay with prismatic and blocky structure. These soils typically occur in the outer parts of valleys. They make up about 40 percent of the association.

The Straw soils are similar to the Savage soils but have less clay in their subsoil. They occur on fans and on stream terraces and account for about 30 percent of the association.

The Gallatin soils are imperfectly drained and occur in narrow areas that are commonly dissected by the channels of meandering streams. They have a thick, dark surface layer and a somewhat lighter colored subsoil. These soils are subject to overflow and have a water table 2 to 6 feet below the surface. They account for about 10 percent of the association.

Also in the association are the Twin Creek and the Judith soils. The Twin Creek soils are in the southern extremities of the association, where they occur on some of the fans and low terraces. They are deep and loamy and dark reddish in color. These soils make up about 5 percent of the association. The Judith soils occur on low terraces. They have a dark-colored surface layer and a light-colored, strongly calcareous subsoil that merges with very gravelly material at a moderate depth. They amount to about 5 percent of the association.

The remaining 10 percent of this association consists of small areas of well-drained and poorly drained clays and clay loams. Figure 3 shows the relationship of the soils in this association as they occur in the vicinity of Hobson on the terraces along the Judith River.

Combination grain and livestock ranches are on this association and extend onto adjoining associations. About 50 percent of the association is used for hay, and about 10 percent for pasture; some of the hay and pasture is irrigated. The rest of the association is in native range. The size of the ranches ranges from about 600 to 2,000 acres. The soils take in water rapidly and have good capacity for storing moisture except where they are underlain by gravel at a moderate depth. The main management needs are conserving moisture and controlling wind erosion on the dryfarmed parts of the association and distributing water evenly and renovating hay stands periodically on the irrigated parts.

4. Judith-Ashuelot association: Gravelly loams moderately deep over very gravelly material or shallow over a lime-cemented hardpan; on nearly level and gently sloping high benches

This association occupies an area of high benches that begins about 5 miles southwest of Hobson and covers about 11,500 acres. The soils in this association are dark colored and well drained. They developed in gravelly loam alluvium, underlain near the surface or at a moderate depth by very gravelly material. Their native vegetation consists of mid grasses.

The Judith soils have a dark-colored gravelly loam surface layer underlain by light-colored, strongly calcareous gravelly loam that grades to very gravelly material at a moderate depth. These soils make up about 80 percent of the association.

The Ashuelot soils account for the remaining 20 percent of the association. They occur in spots that cannot be predicted by observing the topography. Their dark-colored surface layer averages about 4 inches in thickness and is underlain by light-colored, strongly calcareous gravelly loam that extends to a hardpan cemented with lime. The hardpan is at an average depth of about 8 inches.

About 80 percent of this association is used for small grain and about 20 percent for tame pasture. The rest is in native range. The Judith soils produce moderate yields of small grain, but the Ashuelot soils are droughty and are further limited by cobbles and the cemented hardpan, which damage machinery. One of the management needs is conserving moisture. Some of the cropland of this association probably should be seeded to grass.

5. Lismas-Shale land association: Shallow clays and outcrops of shale on steep, rough, broken topography

This soil association occupies the spectacular area that geologic erosion has carved out along Arrow Creek and the lower part of Surprise Creek. The area is locally called shale breaks. The creeks and their tributaries are deeply cut into the clay shale and into the Lismas clay, which is shallow over shale. Lismas clay occurs on the steep and very steep, rounded slopes and makes up 60 percent of the association. The shale crops out on very steep slopes and makes up about 20 percent.

Other soils in the association include Pierre clay, Saline land, and small areas of soils on bottom lands and uplands.

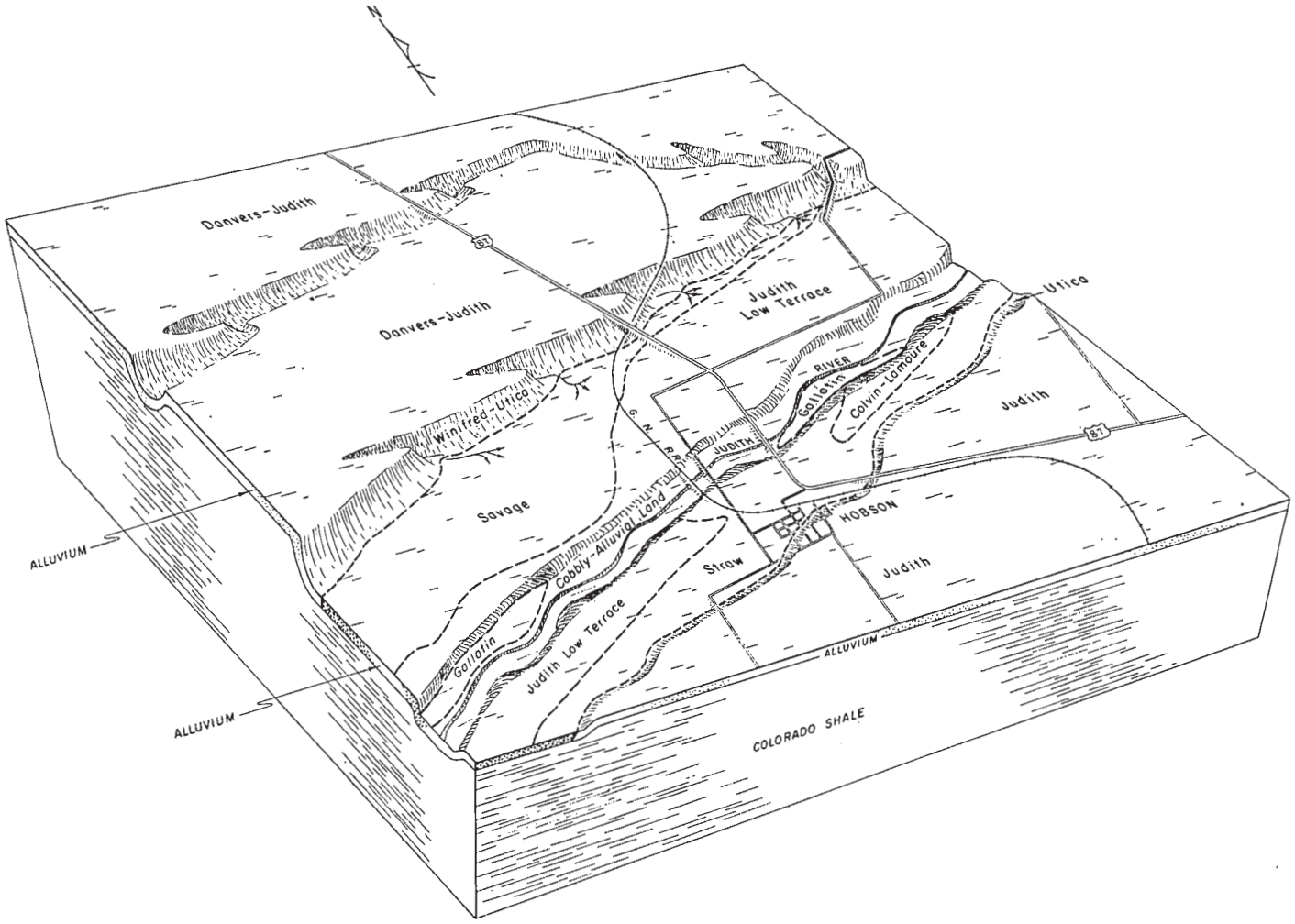

Figure 3.—**Representative pattern of soils in the Savage-Straw-Gallatin association (lower half of figure).**

Pierre clay is moderately deep over shale clay and accounts for about 10 percent of the association. Saline land occurs on moderately steep slopes below the shale breaks and makes up about 5 percent of the association. Soils on bottom lands and on uplands make up the remaining 5 percent.

The soils in this association take in water slowly and have rapid runoff. Generally, yields of forage are low. The association has no farmsteads, but it is grazed by livestock belonging to farmers and ranchers of adjoining soil associations. One of the problems of management is properly distributing grazing on the rough terrain. Some access trails have been constructed, and some springs have been developed.

6. Absarokee-Maginnis association: Dark-colored clay loams that are moderately deep and channery clay loams that are shallow over hard shale and sandstone; on sloping to steep uplands

This soil association consists of moderately deep and shallow soils on gentle to steep slopes of the rolling uplands in the plains section. Its main area is north of the town of Geyser, and a smaller area is east and south of the town of Windham. The total area of this association is about 45,000 acres.

The Absarokee soils have a dark-colored clay loam surface layer about 4 inches thick. Their subsoil is firm, grayish-brown or dark grayish-brown clay with prismatic and blocky structure. These soils occur mainly on gentle to moderate slopes but partly on moderately steep slopes. They account for 40 percent of the association.

The Maginnis soils lack the distinct, blocky subsoil of the Absarokee soils and are shallow or very shallow to bedrock. They occur on the crest of ridges and on steep side slopes of drainageways. Maginnis soils amount to about 40 percent of the association.

These major soils are free of lime. The Absarokee soils take in water readily to somewhat slowly and have good capacity for storing moisture. The shallow Maginnis soils are droughty and, because they are steep, have rapid runoff.

Rhoades, Arvada, Savage, Danvers, and other soils are also in this association. The Rhoades and Arvada soils have a claypan and are underlain by bedrock. They occur together and make up about 5 percent of the association. The surface layer of the Rhoades soils is moderately thick, and that of the Arvada soils is thin. The Savage and Danvers soils together also make up about 5 percent of

the association. The Savage soils are on fans, and the Danvers soils are on remnants of benches. Both have a dark, moderately fine textured surface layer and a grayish-brown, blocky subsoil, but the Savage soils lack the gravel substratum of the Danvers soils. The remaining 10 percent of the association is made up of soils that are largely nontillable because they are shallow or contain too many stones.

Combination grain and livestock ranches occur on this association. About 70 percent is native range. About 25 percent is cultivated, and about 5 percent is seeded to tame pasture. Most of the association is made up of ranches as large as 4,000 acres, but there are smaller ranches of about 640 acres. On the cropland, the main problem is conserving moisture and lessening erosion. On range, grazing should be properly distributed so that the most productive kinds of grasses are kept or encouraged.

7. Cheadle-Darret-Fergus association: Dark-colored, shallow, loamy soils over sandstone and reddish, moderately deep, loamy soils over shale; mainly on moderate to steep slopes in the uplands

This soil association is north of the Little Belt Mountains on the upland parts of the lower foothills. It extends diagonally across the survey area in a northwest-southeast direction. Narrow valleys are included. Much of the association consists of shallow to moderately deep loams and clay loams on slopes ranging from moderate to very steep. Much of the soil material is reddish colored. This soil association has a total area of about 105,000 acres.

The Cheadle soils occur on ridges, crests, and steep slopes and are dark and generally stony or channery. These soils make up about 35 percent of the association.

The Darret soils occur on moderately steep slopes and have a surface layer that is of dark-reddish color and about 4 inches thick. It is underlain by about 10 inches of dark reddish-gray to pale-red material that has prismatic and blocky structure. Some lime has accumulated in the lower part of the subsoil, which merges with interbedded shale and sandstone at a moderate depth. Darret soils amount to about 30 percent of the association.

The Fergus soils are similar to the Darret soils but are deeper to bedrock. They occupy gentle to moderate slopes and occur in the valleys, as well as on the mantled uplands. These soils account for about 25 percent of the association.

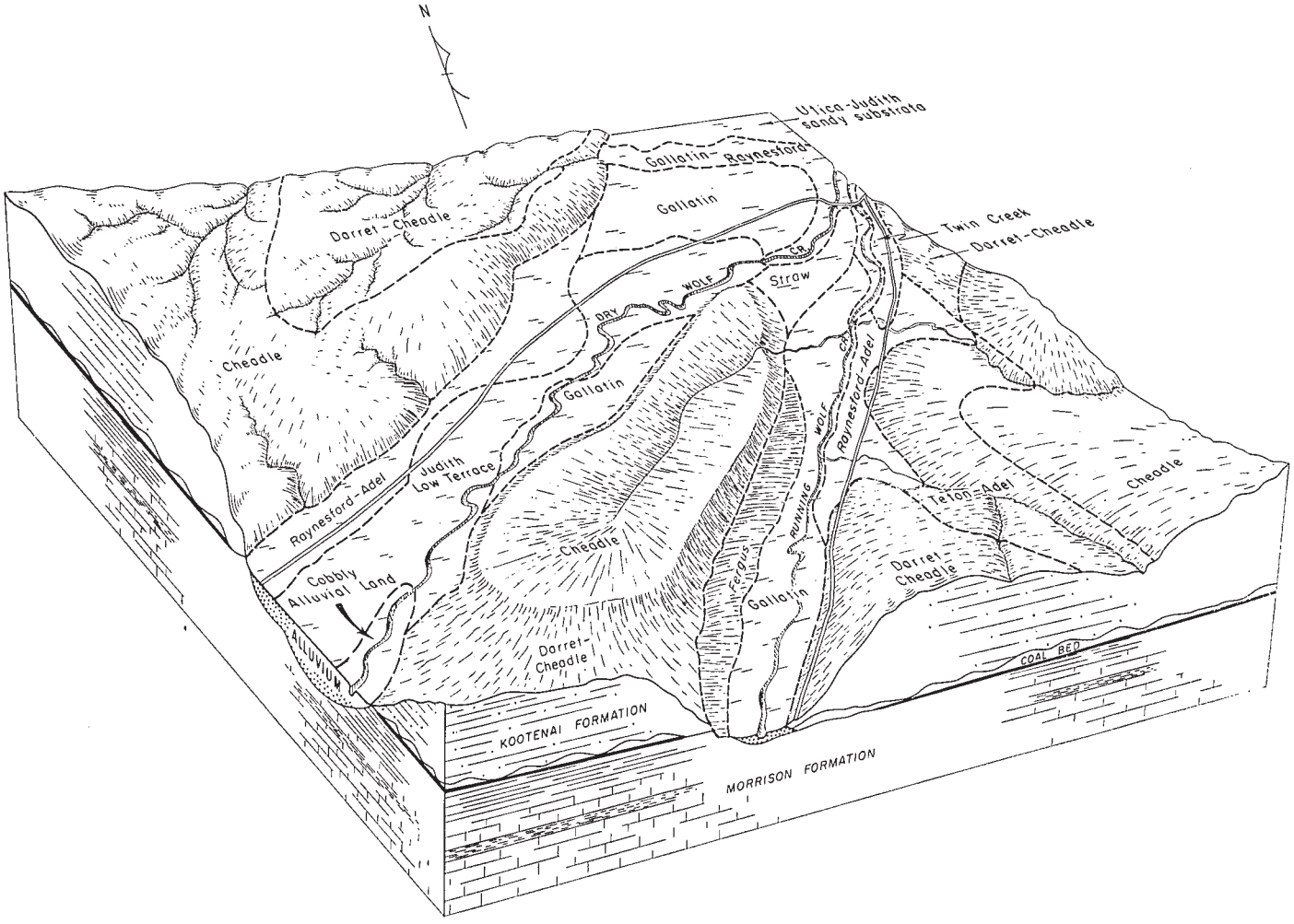

Figure 4.—Representative patterns of soils in the Cheadle-Darret-Fergus association.

Also in this association are Twin Creek, Raynesford, Adel, Judith, Gallatin, and Terrad soils. The Twin Creek, Raynesford, Adel, and Judith soils are on small fans and narrow terraces in the valleys and together account for 5 to 8 percent of the association. The Twin Creek soils are deep, loamy, and dark reddish in color. The Raynesford and Adel soils are deep, loamy, and very dark. Gallatin soils occur on narrow bottoms along streams and amount to 2 to 5 percent of the association. They are deep, loamy, and imperfectly drained. The Terrad soils are dark-reddish clays that occur on rolling uplands and have a blocky subsoil. They make up less than 1 percent of the association. Figure 4 shows the relationship of the major soils and some of the minor soils in the Cheadle-Darret-Fergus association.

This soil association is used mainly for ranching. A large part of the association is too stony, too shallow, or too steep for cultivation. Hay is produced on the soils in the valleys, and small grain is produced on some of the deeper, stone-free, moderately steep soils of the uplands. But only about 15 percent of the association is used for small grain and hay. Ranches in this association range from 1,000 to 30,000 acres in size, but the average size is about 4,000 acres. One of the problems in range management is proper distribution of livestock so that grazing is uniform and at an intensity that permits good growth of the most desirable, highest producing grasses.

8. Teton-Cheadle association: Dark-colored loams deep and shallow over sandstone; on gentle to steep slopes in the uplands

This soil association occupies noncontiguous areas of foothills north of the Little Belt Mountains. The soils are very dark, are gently sloping to steep, and shallow to deep over sandstone. The soils developed under a dense cover of mid and tall grasses. The association has a total area of about 33,000 acres.

The Teton soils occur on gentle to moderately steep slopes and have a nearly black loam surface layer 8 to 10 inches thick. Their blocky subsoil is lighter colored than the surface layer, is not calcareous, and is underlain by bedrock at a depth of 24 to 50 inches. These soils make up about 50 percent of the association.

The Cheadle soils generally occur on ridges, crests, and steep slopes, but in some places they are on gentle to moderate slopes. They are loamy soils that are shallow or very shallow over sandstone and, in most places, are stony or channery. Cheadle soils amount to about 40 percent of the association.

The remaining 10 percent of the association is made up mainly of Adel soils, but there are lesser amounts of Skaggs and Duncom soils. The Adel soils are on foot slopes and fans and are deep, very dark colored, loamy, and generally stony. The Skaggs soils are moderately deep over bedrock and are very dark colored, loamy, and strongly calcareous in the subsoil. Duncom soils are stony loams that are shallow over bedrock.

This soil association is used for ranching. Much of it is too steep, too stony, or too shallow for cultivation, but there are some areas of deep, stone-free soils that are well suited. In these areas good yields of small grain can be expected, for the annual precipitation totals 20 to 24 inches. The farming operations, however, must be timely because there are only slightly more than 95 frost free days. About 85 percent of this association is in native range, and the rest is in small grain, hay, and tame pasture. Range management is needed that permits the most desirable and highest producing grasses to take root and spread.

9. Skaggs-Duncom association: Nearly black, moderately deep and shallow, loamy soils over limestone; on moderate to steep slopes in the uplands

This soil association occupies the irregularly sloping uplands in the higher foothills that border the Little Belt Mountains on the north (fig. 5). The soils occur on gentle to steep slopes and are loamy, very dark, and moderately deep to shallow over limestone. A few gently sloping plateaus are bordered by deep drainageways. Prominent ledges of limestone crop out on ridges and on steep slopes along drains. These soils developed under a cover of mid and tall grasses, but scattered conifers occur in many places.

The Skaggs soils have a nearly black loam surface layer 4 to 8 inches thick. Their light-colored, strongly calcareous subsoil is underlain by bedrock at a moderate depth. These soils occur on gentle to moderately steep slopes and make up about 55 percent of the association.

The shallow, stony Duncom soils occur on ridges, on crests, and on some of the lesser slopes. They amount to about 25 percent of the association.

Also in this association are Raynesford, Adel, and Little Horn soils. Raynesford and Adel soils occur on fans and make up about 10 percent of the association. The Raynesford soils are deep and loamy. Their nearly black surface layer is about 12 inches thick and grades to a lighter colored, strongly calcareous subsoil. The Adel soils have a much thicker surface layer than the Raynesford soils. Little Horn soils occur on rolling uplands and account for less than 5 percent of the association. They are moderately deep over bedrock and have a very dark colored stony loam surface layer about 6 inches thick. Their subsoil is brown to dark-brown, blocky clay loam in which lime has accumulated in the lower part. Small areas of other soils make up the remaining 5 percent of the association.

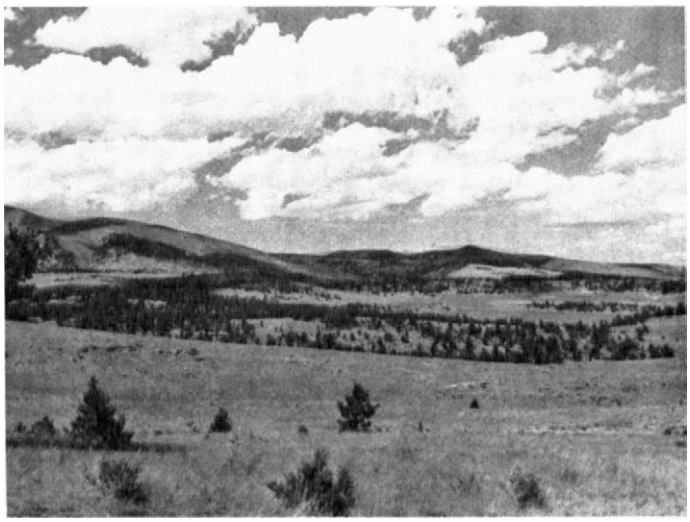

Figure 5.—**Typical view of Skaggs-Duncom association showing Little Belt Mountains in background.**

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This soil association is part of the foothills area and is used for ranches. Most of it is in native range, but small grain and hay are produced on the deep, loamy soils of the fans and on the deep, stone-free soils of the uplands. Although the growing season is short, profitable yields of small grain and hay are produced if farm operations are timely. Much of the association, however, is too stony, too shallow, or too steep for cultivation. Good range management is of great importance.

10. Hughesville-Duncom association: Moderately deep, loamy, forested soils and grass-covered soils shallow over limestone; on mountain slopes

This soil association is the generally wooded fringe of the Little Belt Mountains along the southwestern boundary of the survey area (fig. 6). The soils are loamy and moderately deep or shallow over limestone. These soils developed under thick stands of timber that are spotted with areas where the stands are more open and are grass covered.

The Hughesville soils occur in the thickly wooded areas and make up 50 percent of the association. They are covered with a thin layer of forest litter. The mineral surface layer is gray, loamy, and about 1 inch thick. The subsoil is grayish-brown, blocky clay about 1 foot thick. It is underlain by calcareous material, and that, in turn, by bedrock at a moderate depth.

The Duncom soils are shallow and very shallow stony loams over limestone. These soils occur in grass-covered areas on ridges and sharp crests. They amount to about 40 percent of the association.

Skaggs and Raynesford soils and outcrops of rock make up most of the remaining 10 percent of the association. The Skaggs soils are grass covered and are loamy and moderately deep over bedrock. They have a nearly black surface layer and a light-colored, strongly calcareous subsoil. The Raynesford soils are on alluvial fans and are deep and loamy. They have a nearly black surface layer about 1 foot thick and a light-colored, strongly calcareous subsoil. The outcrops of rock are prominent on the broken slopes of the canyon walls.

This association produces posts and poles that are used locally. It also provides some grazing for livestock. It is part of a valuable watershed that helps to regulate the flow of streams and to replenish the supply of underground water.

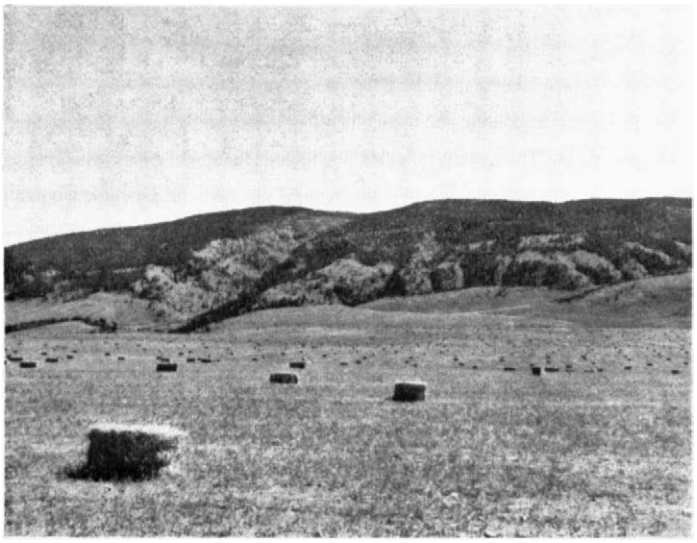

Figure 6.—**Typical view of Hughesville-Duncom association in background; Judith gravelly clay loam in foreground.**

11. Cowood association: Shallow to moderately deep, forested soils on steep and very steep mountain slopes and intermingled with barren igneous rock in some places

This soil association occupies the eastern part of the Highwood Mountains in the northwestern part of the survey area. It is a rugged mountainous area that has prominent outcrops of igneous rocks on ridges and steep slopes. The vegetation consists of sparse and moderately thick stands of timber. The association covers an area of about 4,500 acres.

The Cowood soils are covered by a thin layer of forest litter. Their surface layer is light colored, generally gravelly or stony loam and is about 6 inches thick. It is underlain by a grayish-brown, porous subsoil that merges with igneous bedrock at a depth of 1 to 3 feet. These soils make up about 70 percent of the association, and the igneous outcrops amount to about 15 percent.

Spring Creek, Woodhurst, and Loberg soils are also in this association. The Spring Creek soils amount to about 10 percent. They are very shallow stony loams in steep grass-covered areas. The Woodhurst soils are very dark, moderately deep very stony loams in steep and moderately steep grassed areas. They account for less than 5 percent of the association. The Loberg soils also account for less than 5 percent. They are deep, light-colored, moderately fine textured soils that occur on a few of the forested lower slopes.

This soil association produces posts, poles, and other wood products, but the terrain is so rugged that parts of it are nearly inaccessible. The areas under grass furnish limited grazing for livestock. This association is one of the habitats for deer and elk in the survey area, and it is a watershed that helps regulate the flow of streams.

12. Sapphire-Woodhurst-Teton association: Forested, loamy soils moderately deep over sandstone and grass-covered, loamy soils moderately deep over igneous rock and sandstones; on steep, smooth slopes of the Highwood Mountains

This soil association occupies the western half of the Highwood Mountains. Slopes are steep and very steep on large, rounded mountains, and there is little rock outcrop. About half of the association is covered with thick stands of ponderosa and lodgepole pines, and the other half is grassland. This soil association covers an area of about 4,000 acres.

The Sapphire soils developed under forest vegetation, generally on the mid and lower slopes. A cover of forest litter is underlain by a mineral surface layer of light-colored loam about 8 inches thick. The subsoil is a light brownish, blocky clay that is underlain by sandstone at a moderate depth. These soils make up about 50 percent of the association.

The Woodhurst soils are moderately deep, lime-free soils that are in grass and are underlain by igneous rock. Their surface layer is nearly black very stony loam about 1 foot thick. Their subsoil is brown to dark grayish-

brown clay loam with blocky structure. These soils amount to about 25 percent of the association.

The Teton soils are moderately deep, as are the Woodhurst soils, but have less stone and are underlain by sandstone instead of igneous rock. They are intermingled with the Woodhurst soils in the grassland and amount to about 10 percent of the association.

Also in the association are the Cheadle and Adel soils. The Cheadle soils are on slight ridges covered with grass. They are shallow and very shallow, loamy, and underlain by sandstone. Cheadle soils amount to nearly 10 percent of the association. The Adel soils occur on foot slopes and fans and are deep, black, and loamy. These Adel and other soils make up the rest of the association.

The soils in this association are too steep and too stony for cultivation, but the grassland provides good grazing in summer. The wooded part is a source of posts, poles, and other wood products and is valuable as a watershed that regulates the flow of streams and replenishes the supply of underground water.

13. Bridger-Woodhurst association: Deep stony and nonstony loams on gentle to moderately steep slopes and moderately deep stony loams over igneous rock; on steep and moderately steep slopes of the foothills

This soil association occupies the sloping benches and choppy foothills east and south of the Highwood Mountains in the northern part of the survey area. The association is stony in most places and is dissected by several drains.

The Bridger soils have a very dark colored, stony or nonstony loam surface layer 6 to 10 inches thick. Their blocky subsoil is brown, heavy clay loam about 20 inches thick. It grades to light-colored, gravelly or stony loam in which lime has accumulated. The Bridger soils occur on sloping benches and foot slopes and make up about 50 percent of the association.

The Woodhurst soils are moderately deep very stony loams that are free of lime and are underlain by igneous rock. Their surface layer is nearly black and about 1 foot thick. Their subsoil is brown to dark grayish-brown clay loam with blocky structure. These soils occur on the side slopes of the choppy foothills and amount to about 20 percent of the association.

Also in the association are large areas of Spring Creek soils and smaller areas of Castle, Raynesford, Adel, Cheadle, and Gallatin soils. The Spring Creek soils amount to about 20 percent of the association, and the rest of these minor soils together amount to about 10 percent. The Raynesford and Adel soils are deep, very dark, and loamy. They occur on fans. The Castle soils are very dark colored clays on moderately steep slopes in the foothills. The Adel soils have a thicker surface layer than the Raynesford soils. The Cheadle soils are dark, very shallow stony loams over sandstones on ridges. The Gallatin soils are on narrow bottoms along drains and are deep, dark, imperfectly drained, and loamy.

Most of this association is in native range. Because of the many stones, the steep slopes, or both, most areas are not suitable for cultivation. The stone-free soils along the drainageways are used for meadow, some of which is irrigated. This association is good for ranching, but appropriate management is needed to prevent overgrazing.

14. Alder-Maginnis association: Very dark or dark, moderately deep clay loams and shallow or very shallow channery clay loams over hard shale and sandstone; on sloping to steep uplands

This association is on high uplands southwest of the Highwood Mountains. Gently sloping to moderately sloping plateaus and drains with short, steep slopes are characteristic. The association has a total area of about 18,000 acres.

The Alder soils have a very dark colored clay loam surface layer 4 to 12 inches thick. Their subsoil is firm, blocky, grayish-brown clay about 2 feet thick. It is underlain by hard shale and sandstone. These soils occur on gentle to moderately steep slopes and make up about 50 percent of the association.

The Maginnis soils are shallow or very shallow channery clay loams over hard shale and sandstone. They occur on crests of slopes and on steep side slopes of rolling areas adjoining plateaus. They account for nearly 30 percent of the association.

Most of the rest of the association consists of Adel, Blythe, Bridger, and Woodhurst soils. The Adel soils occur on fans and gently sloping terraces and are deep, very dark colored, and loamy. The Blythe soils have a moderately thick, very dark loam surface layer and a subsoil with a claypan. The Bridger soils occur on fans and have a very dark loam surface layer 6 to 10 inches thick and a brown, blocky clay loam subsoil that grades to calcareous gravelly loam. The Woodhurst soils are very stony loams that are underlain by igneous rock. They are hilly, moderately deep, and very dark colored.

This soil association is a combination grain and livestock area. About 35 to 40 percent of it is used to produce small grain and hay. The moderately deep soils on the plateaus and the deep soils on the fans and terraces are used for crops. Good yields can be expected, for the average annual precipitation is about 20 inches. Timely farm operations are necessary, however, because the growing season is short. Under cultivation, the moderately steep soils are extremely susceptible to water erosion. Because the soils are shallow, stony, or steep, much of the association is not tillable, but it is good to fair for range. Maintaining uniform grazing of the proper intensity is one of the problems of range management.

Descriptions of the Soils

This section describes the soil series (group of soils) and single soils (mapping units) of the Judith Basin survey area. Many soils are so intermingled that they are mapped together in a complex. Other soils are mapped together in undifferentiated soil groups. The acreage and proportionate extent of each mapping unit, including the complexes and the undifferentiated soil groups, are given in table 1.

The procedure in this section is first to describe the soil series, and then the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the Section "How Soils Are Mapped and Classified," not all mapping units are members of a soil series.

Clayey alluvial land, Cobbly alluvial land, and Saline land are miscellaneous land types and do not belong to a soil series, but they are listed in alphabetic order along with the soil series. The acreage of these land types is also given in table 1.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit or units and the range site in which the mapping unit has been placed. The pages on which each capability unit and each range site are described can be found readily by referring to the "Guide to Mapping Units," at the back of the report.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*

Map symbol	Soil name	Area	Extent	Map symbol	Soil name	Area	Extent
		Acres	*Percent*			*Acres*	*Percent*
Aa	Absarokee clay loam, 2 to 8 percent slopes	17, 779	2. 0	Cs	Cheadle-Duncom-Rock outcrop complex	9, 925	1. 1
Ab	Absarokee clay loam, 8 to 15 percent slopes	1, 190	. 1	Ct	Clayey alluvial land	1, 850	. 2
Ac	Absarokee silty clay, 2 to 8 percent slopes	3, 412	. 4	Cu	Cobbly alluvial land	1, 925	. 2
Ad	Absarokee-Cheadle channery loams, 2 to 8 percent slopes	962	. 1	Cv	Colvin-Lamoure clay loams	8, 287	. 9
Af	Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded	362	(1)	Cw	Cowood stony loam	1, 862	. 2
Ag	Absarokee-Cheadle stony loams	1, 005	. 1	Cx	Cowood-Rock outcrop complex	3, 275	. 4
Ah	Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes	2, 862	. 3	Da	Danvers clay loam, 0 to 2 percent slopes	13, 887	1. 5
Ak	Adel loam, 2 to 8 percent slopes	350	(1)	Db	Danvers clay loam, 2 to 4 percent slopes	4, 575	. 5
Al	Adel loam, 8 to 18 percent slopes	355	(1)	Dc	Danvers clay loam, 4 to 8 percent slopes	310	(1)
Am	Adel silt loam, terrace	640	(1)	Dd	Danvers cobbly clay loam, 0 to 4 percent slopes	6, 862	. 8
An	Alder clay loam, 2 to 8 percent slopes	4, 640	. 5	Df	Danvers cobbly clay loam, 4 to 8 percent slopes	2, 380	. 3
Ao	Alder clay loam, 8 to 15 percent slopes	2, 637	. 3	Dg	Danvers cobbly clay loam, 8 to 15 percent slopes	800	(1)
Ap	Alder stony clay loam, 8 to 15 percent slopes	540	(1)	Dh	Danvers gravelly clay loam, 0 to 4 percent slopes	4, 112	. 5
Ar	Alder-Maginnis channery clay loams, 2 to 8 percent slopes	400	(1)	Dk	Danvers stony clay loam, 2 to 4 percent slopes	3, 412	. 4
As	Alder-Maginnis complex, 8 to 35 percent slopes	3, 430	. 4	Dm	Danvers-Judith clay loams, 0 to 2 percent slopes	57, 680	6. 4
At	Arvada-Beckton cobbly clay loams	1, 050	. 1	Dn	Danvers-Judith clay loams, 2 to 4 percent slopes	12, 837	1. 4
Au	Arvada-Beckton complex, saline	375	(1)	Do	Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes	3, 450	. 4
Av	Arvada-Laurel complex	7, 537	. 8	Dp	Danvers-Judith gravelly clay loams, 0 to 2 percent slopes	7, 312	. 8
Aw	Arvada-Terrad clays	375	(1)	Dr	Darret clay loam, 8 to 15 percent slopes	3, 600	. 4
Ax	Ashuelot gravelly loam	610	(1)	Ds	Darret stony clay loam	600	(1)
Ba	Bainville loam	360	(1)	Dt	Darret-Cheadle complex, 2 to 8 percent slopes	13, 587	1. 5
Bb	Beckton loam	450	(1)	Du	Darret-Cheadle complex, 8 to 35 percent slopes	19, 412	2. 2
Bc	Beckton-Arvada clay loams	10, 350	1. 3	Dv	Darret-Utica complex	6, 350	. 7
Bd	Beckton-Danvers clay loams	537	(1)	Dw	Dimmick clay	160	(1)
Bf	Beckton-Savage complex	2, 975	. 3	Dx	Duncom stony loam	5, 175	. 6
Bg	Blaine-Spring Creek loams, 2 to 8 percent slopes	700	(1)	Dy	Duncom-Rock outcrop complex	5, 025	. 6
Bh	Blaine-Spring Creek stony loams	660	(1)	Dz	Duncom-Skaggs-Rock outcrop complex	11, 524	1. 3
Bk	Blythe loam, 2 to 4 percent slopes	130	(1)	Fa	Fargo-Hegne silty clays	1, 252	. 1
Bm	Blythe loam, 4 to 8 percent slopes	420	(1)	Fc	Fergus clay loam, 0 to 2 percent slopes	1, 412	. 2
Bo	Bowdoin silty clay, low clay variant	1, 437	. 2	Fd	Fergus clay loam, 2 to 4 percent slopes	1, 350	. 1
Bp	Bridger loam, 2 to 4 percent slopes	660	(1)	Ff	Fergus clay loam, 4 to 8 percent slopes	125	(1)
Br	Bridger loam, 4 to 15 percent slopes	725	(1)	Fh	Fergus clay loam, 8 to 15 percent slopes	90	(1)
Bs	Bridger stony loam	2, 377	. 3	Fs	Fergus silty clay loam, shale substratum, 2 to 8 percent slopes	16, 237	1. 8
Ca	Castle clay, 4 to 15 percent slopes	830	(1)	Ga	Gallatin clay loam	3, 612	. 4
Cb	Castle clay, 15 to 35 percent slopes	1, 350	. 1	Gb	Gallatin loam	1, 737	. 2
Cc	Castle complex	2, 700	. 3	Gc	Gallatin loam, clay substratum	520	(1)
Cd	Chama clay loam, 4 to 8 percent slopes	410	(1)	Gd	Gallatin soils, wet	4, 712	. 5
Cf	Chama-Midway clay loams, 4 to 8 percent slopes	120	(1)	Gr	Gallatin and Raynesford loams	19, 262	2. 1
Cg	Chama-Midway clay loams, 8 to 15 percent slopes	200	(1)	Hu	Hughesville-Duncom complex	3, 800	. 4
Ch	Cheadle-Big Timber-Rock outcrop complex	11, 675	1. 3	Ja	Judith-Ashuelot gravelly loams, 0 to 4 percent slopes	11, 175	1. 2
Ck	Cheadle channery loam, 2 to 8 percent slopes	1, 187	. 1				
Cm	Cheadle channery loam, 8 to 15 percent slopes	4, 970	. 6				
Cn	Cheadle loam, 2 to 8 percent slopes	1, 161	. 1				
Co	Cheadle loam, 8 to 15 percent slopes	6, 737	. 7				
Cp	Cheadle stony loam	23, 012	2. 6				
Cr	Cheadle-Rock outcrop complex	3, 710	. 4				

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Map symbol	Soil name	Area	Extent	Map symbol	Soil name	Area	Extent
		Acres	*Percent*			*Acres*	*Percent*
Jb	Judith clay loam, 0 to 2 percent slopes	8, 300	.9	Sk	Savage silty clay loam, 4 to 8 percent slopes	1, 010	.1
Jc	Judith clay loam, 2 to 4 percent slopes	2, 525	.3	Sl	Skaggs loam	3, 690	.4
Jd	Judith clay loam, 4 to 8 percent slopes	675	(1)	Sm	Skaggs clay loam, 4 to 8 percent slopes	2, 650	.3
Jf	Judith clay loam, low terrace	16, 075	1.8	Sn	Skaggs clay loam, 8 to 15 percent slopes	2, 550	.3
Jh	Judith cobbly clay loam, 0 to 4 percent slopes	1, 725	.2	So	Skaggs stony clay loam	9, 512	1.1
Jk	Judith cobbly clay loam, low terrace, 0 to 4 percent slopes	2, 937	.3	Sp	Skaggs-Cheadle complex	790	(1)
Jl	Judith gravelly clay loam, 0 to 2 percent slopes	21, 437	2.4	Sr	Skaggs-Duncom stony clay loams	26, 350	2.9
Jm	Judith gravelly clay loam, 2 to 4 percent slopes	38, 462	4.2	Ss	Skaggs-Raynesford loams, 8 to 35 percent slopes	13, 250	1.5
Jn	Judith gravelly clay loam, 4 to 8 percent slopes	15, 200	1.7	St	Skaggs-Duncom-Hughesville complex	4, 125	.5
Jo	Judith gravelly clay loam, low terrace, 0 to 4 percent slopes	2, 775	.3	Su	Slocum loam	187	(1)
Jp	Judith-Danvers gravelly clay loams, 0 to 4 percent slopes	2, 350	.3	Sv	Spring Creek-Blaine stony loams	4, 650	.5
Jr	Judith and Raynesford stony loams, 2 to 8 percent slopes	2, 862	.3	Sw	Straw clay loam, 0 to 2 percent slopes	4, 462	.5
Js	Judith and Raynesford stony loams, 8 to 15 percent slopes	1, 560	.2	Sx	Straw clay loam, 2 to 4 percent slopes	3, 717	.4
Jt	Judith and Savage soils	1, 180	.1	Sy	Straw clay loam, gravelly substratum	5, 325	.6
Ju	Judith-Utica gravelly loams, 4 to 8 percent slopes	112	(1)	Ta	Terrad clay, 2 to 8 percent slopes	2, 950	.3
Jv	Judith-Utica gravelly loams, 8 to 15 percent slopes	5, 537	.6	Tb	Terrad clay, 8 to 35 percent slopes	100	(1)
La	Lismas-Pierre clays	3, 225	.4	Tc	Terrad silty clay, 0 to 2 percent slopes	200	(1)
Lc	Lismas-Shale outcrop complex	9, 725	1.1	Td	Teton loam, 2 to 8 percent slopes	6, 050	.7
Lh	Little Horn stony loam	3, 212	.4	Tf	Teton loam, 8 to 15 percent slopes	800	(1)
Lo	Loamy alluvial land	1, 600	.2	Th	Teton-Adel stony loams	14, 662	1.6
Lr	Loberg stony loam	1, 050	.1	Tk	Teton-Cheadle channery loams, 4 to 15 percent slopes	612	(1)
Ls	Loberg-Sapphire complex	225	(1)	Tm	Teton-Cheadle stony loams, 4 to 15 percent slopes	6, 800	.8
Ma	Maginnis cobbly clay loam	10, 225	1.	Tn	Teton-Cheadle stony loams, 15 to 35 percent slopes	3, 225	.4
Mb	Maginnis-Absarokee channery clay loams	15, 160	1.7	To	Twin Creek loam, 2 to 4 percent slopes	2, 775	.3
Mc	Maginnis-Alder channery clay loams	3, 120	.3	Tp	Twin Creek loam, 4 to 8 percent slopes	1, 070	.1
Mw	Midway clay loam	4, 287	.5	Tr	Twin Creek loam, 8 to 15 percent slopes	250	(1)
Mx	Midway-Shale outcrop complex	750	(1)	Tw	Twin Creek clay loam, 0 to 2 percent slopes	2, 612	.3
Pc	Pierre clay, 2 to 8 percent slopes	950	.1	Ua	Utica gravelly loam, 2 to 8 percent slopes	1, 950	.2
Pd	Pierre clay, 8 to 35 percent slopes	6, 000	.7	Ub	Utica gravelly loam, 8 to 35 percent slopes	7, 237	.8
Pm	Promise clay, 0 to 2 percent slopes	2, 440	.3	Ug	Utica-Judith gravelly loams, sandy substratum	1, 195	.1
Po	Promise clay, 2 to 8 percent slopes	18, 502	2.1	Uh	Utica-Judith stony loams	140	(1)
Pp	Promise clay, 8 to 15 percent slopes	4, 612	.5	Wa	Wet land	2, 562	.3
Pr	Promise cobbly clay	280	(1)	Wb	Winifred clay loam, 0 to 4 percent slopes	5, 250	.6
Ra	Raynesford and Adel loams, 2 to 4 percent slopes	950	.1	Wc	Winifred clay loam, 4 to 8 percent slopes	22, 057	2.5
Rd	Raynesford and Adel loams, 4 to 8 percent slopes	2, 875	.3	Wd	Winifred clay loam, 8 to 15 percent slopes	7, 287	.8
Rf	Raynesford and Adel loams, 8 to 15 percent slopes	1, 775	.2	Wf	Winifred cobbly clay loam, 2 to 8 percent slopes	2, 252	.3
Rn	Raynesford and Adel stony loams, 4 to 15 percent slopes	3, 000	.3	Wh	Winifred cobbly clay loam, 8 to 15 percent slopes	2, 987	.3
Ro	Rhoades-Arvada complex	3, 275	.4	Wk	Winifred-Judith clay loams	5, 475	.6
Sa	Saline land	112	(1)	Wm	Winifred-Rhoades clay loams	4, 337	.5
Sb	Sapphire soils	1, 225	.1	Wn	Winifred-Utica clay loams	40, 812	4.6
Sc	Sapphire-Cheadle complex	1, 900	.2	Wo	Woodhurst stony loam	3, 777	.4
Sd	Savage silty clay, 0 to 2 percent slopes	10, 125	1.1	Wp	Woodhurst-Alder stony complex	2, 500	.3
Se	Savage silty clay, 2 to 4 percent slopes	1, 975	.2	Wr	Woodhurst-Loberg complex	2, 080	.2
Sf	Savage silty clay, 4 to 8 percent slopes	680	(1)	Ws	Woodhurst-Spring Creek stony complex	3, 212	.4
Sg	Savage silty clay loam, 0 to 2 percent slopes	12, 392	1.4	Wt	Woodhurst-Teton-Cheadle soils	2, 200	.2
Sh	Savage silty clay loam, 2 to 4 percent slopes	1, 125	.1		Total	897, 980	100.0

[1] Less than 0.1 percent.

Soil scientists, engineers, students, and others who want detailed descriptions of soil series should turn to the section "Formation and Classification of Soils." Many terms used in the soil descriptions in other sections of the report are defined in the Glossary.

Absarokee Series

The Absarokee series consists of dark-colored, well-drained soils that are underlain by bedrock at an average depth of 26 inches. These soils occur in the plains area of the rolling uplands and have gentle to moderately steep slopes. The native vegetation is dominantly mid grasses.

Absarokee clay loams are the most extensive and most representative soils of this series. They have a granular, dark grayish-brown surface layer that is less than 4 inches thick and is easily worked. It is underlain by a dark grayish-brown or dark yellowish-brown subsoil that averages about 20 inches in thickness and has strong, blocky structure. The subsoil contains distinctly more clay than the surface layer; it is underlain by alternate layers of hard shale and sandstone. The parent material is largely clay loam weathered in place from bedrock, but is partly alluvium and windblown material.

The surface layer of these soils ranges from loam to silty clay. Depth to bedrock ranges from 18 to 36 inches. The surface layer and the subsoil are noncalcareous. In some places there is a layer containing an accumulation of white lime just above or in the bedrock. Generally, however, Absarokee soils do not contain calcium carbonate.

These soils have fairly good moisture-storage capacity, a moderate supply of organic matter, and high natural fertility. The rate of water intake varies.

The Absarokee soils have a thinner, lighter colored surface layer than the Alder soils. Their blocky subsoil distinguishes them from the closely associated Maginnis soils, which have little or no subsoil.

Absarokee clay loam, 2 to 8 percent slopes (Aa).—This soil occurs on rolling upland plains that have gentle to moderate slopes. It has a profile like the one described as representative of the Absarokee series.

Included on knolls in areas mapped as this soil are areas of Absarokee channery clay loam that are generally less than 1 acre in size. These areas make up less than 5 percent of any mapped area. Also included on knolls are small areas of Maginnis channery clay loam, which is shallow to bedrock.

This soil is productive. Its larger areas are used to produce small grain. The smaller and less accessible areas are in native range or tame pasture. This soil takes in water readily. It is easily tilled, and its surface soil provides a good seedbed. Because runoff is medium, unprotected fields are susceptible to water erosion. Management is needed to control both wind and water erosion if this soil is cultivated. (Capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Absarokee clay loam, 8 to 15 percent slopes (Ab).—This soil occurs on the sides of drainageways and at the edges of areas of Absarokee clay loam, 2 to 8 percent slopes. Except for depth, its profile is much like the one described as representative of the series. Depth ranges from about 18 inches on the the upper slopes to 3 feet or more on the lower slopes.

Included on the crests of slopes in areas mapped as this soil are areas of Maginnis channery clay loam that are less than 1 acre in size and make up less than 10 percent of any mapped area. These inclusions are droughty, conspicuous, and very low in productivity.

Because runoff is rapid on the moderately steep slopes, water erosion is a serious problem. To control erosion, protection provided by firmly anchored living plants is needed. This soil is best suited to hay or pasture. (Capability unit IVe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Absarokee silty clay, 2 to 8 percent slopes (Ac).—This soil occupies foot slopes and gently rolling uplands. A thin mantle of alluvium occurs in some places and is indicated by pebbles and cobbles scattered in the upper part of the profile. In most places shale is at a depth of 2 to 3 feet. The profile of this soil is finer textured throughout than the one described as representative of the Absarokee series.

Included in some areas mapped as this soil are small areas of Absarokee clay loam, 2 to 8 percent slopes, but most areas are relatively pure.

This soil is well suited to small grain, hay, and pasture. It takes in water slowly, however, and is difficult to work. Because the intake of water is slower than that of Absarokee clay loam, 2 to 8 percent slopes, runoff is more rapid and erosion is more likely. If this soil is cultivated, management is needed that lessens runoff and erosion. The granular surface layer is susceptible to wind erosion where it is not protected. (Capability unit IIIe–3, dryland; Clayey range site, 15 to 19 inches precipitation)

Absarokee-Cheadle channery loams, 2 to 8 percent slopes (Ad).—The soils in this complex are Absarokee loam, Cheadle channery loam, and Cheadle sandy loam. They are on rolling uplands.

The Cheadle soils occupy the knolls and ridges, which are generally less than 1 acre in size. These soils are underlain by sandstone at a depth of 12 to 18 inches. Absarokee loam is between the knolls and ridges. Scattered over its surface are angular fragments of sandstone 2 to 6 inches across. Also, the loam has more sand in its surface layer than is typical for Absarokee soils. The Absarokee soil makes up 70 to 80 percent of most mapped areas, and the Cheadle soils make up the rest.

The Absarokee loam takes in water readily. It is productive of hay, small grain, and pasture, but unprotected areas are highly susceptible to wind erosion. The Cheadle soils are droughty because they are shallow. Their yields are low. Because of the sandstone fragments, tilling and harvesting are difficult on the Cheadle soils, and to a lesser degree on the Absarokee soil. Where feasible, it is best to keep the Cheadle soils in pasture. (Absarokee part: capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation. Cheadle part: capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded (Af).—This complex consists of intermingled Absarokee and Cheadle soils on tilted, rolling uplands.

The Cheadle soils occur on knolls and ridges in areas generally less than 1 acre in size. They have a channery loam or channery sandy loam surface layer that is underlain by sandstone at a depth of 10 to 18 inches. The Absarokee soil has a loam surface layer that is moderately

eroded and has, strewn over the surface, angular fragments of sandstone 2 to 6 inches across. It contains more sand than the soil described for the Absarokee series and is not so deep to bedrock. This soil occupies slopes of 8 to 12 percent between and surrounding the ridges and knolls. It makes up 60 to 85 percent of each area mapped, and the Cheadle soils make up the rest.

The Absarokee loam takes in water readily, but runoff is moderate to rapid. Because of this runoff, and because of the sand content of the surface layer, this soil is highly susceptible to both water and wind erosion if it is unprotected. It is best protected where it is used for hay or pasture. The Cheadle soils are droughty and difficult to cultivate because of the sandstone fragments. They produce low yields. Where feasible, it is best to seed the Cheadle soils to permanent grass. (Absarokee part: capability unit IVe–2, dryland; Silty range site, 15 to 19 inches precipitation. Cheadle part: capability unit VIe–5; Silty range site, 15 to 19 inches precipitation)

Absarokee-Cheadle stony loams (4 to 15 percent slopes) (Ag).—This complex is made up of Absarokee loam and stony loam and Cheadle stony loam. It occupies upland plains that have gentle to moderate slopes. Outcrops of bedrock and loose stone are on the surface in many places.

The Cheadle stony loam occupies ridges and knolls, generally in areas that are less than 2 acres in size. It is intermingled with the Absarokee soils. Its profile is much like the one described as representative of the Cheadle series. The Absarokee soils surround the ridges and knolls. The profile of Absarokee loam contains more sand than the profile described as representative of the Absarokee series. Stones generally are not at or on the surface of the Absarokee soils. The areas mapped as this complex consists of 40 to 70 percent Absarokee loam and stony loam, 30 to 50 percent Cheadle stony loam, and less than 2 percent sandstone outcrop.

The Absarokee soils take in water readily and have good moisture-storage capacity. They are well suited as range but are generally not suitable for regular cultivation, because they are stony or are in small, irregularly shaped, nonstony areas. The Cheadle soil is too stony and too shallow for cultivation. It provides only a fair amount of forage for grazing. (Absarokee part: capability unit VIs–2; Silty range site, 15 to 19 inches precipitation. Cheadle part: Capability unit VIIs–2; Shallow range site)

Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes (Ah).—This complex consists of Absarokee clay loam and Maginnis channery clay loam on gently rolling upland plains.

The Maginnis channery clay loam occupies the knolls and other slightly elevated places and is in areas that range from less than 1 acre to 2 acres in size. Its profile is like the one described as representative of the Maginnis series. Depth to bedrock ranges from 8 to 18 inches. The Absarokee soil occurs between the ridges and surrounds the knolls. It is mostly clay loam, but angular fragments of hard sandstone, 1 to 3 inches across, are on the surface and in the profile in varying amounts. Depth to bedrock is generally 18 to 24 inches, or a little less than is typical for the Absarokee series. The Absarokee soil makes up 60 to 80 percent of each mapped area, and Maginnis channery clay loam makes up the rest.

The Absarokee soil takes in water readily but has medium runoff. If it is not protected, this soil is susceptible to water and wind erosion, particularly water erosion. It is suited to hay, small grain, and pasture. The Maginnis soil is shallow and droughty. Yields are relatively low. Because these two soils are intermingled in fields, they are cultivated together in the same way. Where feasible, however, the Maginnis soil should be used for hay or pasture. (Absarokee part: capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation. Maginnis part: capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Adel Series

The Adel series consists of deep, well-drained, very dark colored loams and silt loams. These soils are on fans and stream terraces in the foothills of the survey area. They developed under a dense cover of mid and tall grasses.

Adel loams are the most extensive and most representative soils of the series. They have a crumb-structured, very dark brown to very dark gray surface layer that is about 1 foot thick and is easily worked. The blocky loam or clay loam subsoil is typically dark grayish brown, free of lime, and about 2 feet thick. It grades to material that has weak structure and in which calcium carbonate has accumulated in some places. The parent material is loamy alluvium washed from the uplands.

The surface layer generally ranges from 8 to 18 inches in thickness and from loam to silt loam in texture. Some areas are stony. The subsoil ranges from 15 to 36 inches in thickness. Fragments of sandstone are commonly mixed through the steeper soils that have a loam surface layer.

These soils take in water readily and have good moisture-storage capacity. They are high in organic-matter content and retain plant nutrients well. They are in an area that has a frost-free period of slightly more than 95 days and an annual precipitation of 18 to 24 inches.

The Adel soils have a thicker surface layer than the Raynesford soils, and they lack the prominent accumulation of calcium carbonate that occurs within 16 inches of the surface. They have less clay in their subsoil than the Bridger soils and have fewer coarse fragments below their subsoil. Adel soils lack the sandstone substratum of the Teton soils.

Adel loam, 2 to 8 percent slopes (Ak).—This soil has a profile like the one described for the Adel series. It occurs on fans and foot slopes that are generally 300 to 800 feet long. Slopes are steepest near the apex of the fans, and they are as gentle as 2 percent slopes in the lower part.

This soil is highly productive of hay, small grain, and pasture. It is easily tilled, and its surface soil provides a good seedbed, but unprotected areas are susceptible to water erosion. Although the growing season is short, it is long enough for grain crops to mature. Timely farm operations are needed. (Capability unit IIIe–1, dryland, and IVe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Adel loam, 8 to 18 percent slopes (Al).—This soil is high in the foothills of the survey area on moderately steep foot slopes and fans that are 300 to 600 feet long. It contains a few more fragments of sandstone than the soil described as representative of the Adel series.

This soil is highly productive, but it is best used for hay or pasture because in unprotected cultivated areas, runoff is rapid and water erosion is likely. Machines are difficult to use because slopes are steep and areas of this soil are so small that turning the machine around is hard. Yields of hay and pasture are good. (Capability unit IVe–1, dryland, and IVe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Adel silt loam, terrace (2 to 4 percent slopes) (Am).—This soil is in the foothills of the Highwood Mountains on the gently sloping terraces of narrow valleys. Except for its silt loam surface layer and its silty clay loam subsoil, its profile is like the one described as representative of the Adel series. Because this soil contains a little more clay throughout the profile than is typical of Adel soils, it stores a little more moisture.

Included in the areas mapped as this soil are small areas of Blythe loam.

This soil is well suited to small grain and hay, but irrigated areas are best suited to hay. In unprotected areas water erosion and, to a lesser extent, wind erosion are likely. Because the growing season is short, timely farm operations are needed. (Capability unit IIc–1, dryland, and IIIe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Alder Series

The Alder series consists of very dark colored soils that are about 27 inches deep over bedrock. These soils occur on gentle to moderately steep slopes on the rolling uplands south of the Highwood Mountains. They developed under a dense cover of mid and tall grasses.

Alder clay loams are the most representative soils of the series. They have a crumb surface layer that is 4 inches or more thick and is easily worked. The subsoil contains more clay than the surface layer, and it has distinct blocky structure. It is about 2 feet thick. Its upper part has the same color as the surface layer, but the lower part is grayish brown to light grayish brown. The subsoil generally is underlain by alternate layers of hard shale and sandstone. The parent material consists of clay loam that weathered in place from bedrock and of lesser amounts of alluvium and windblown material.

These soils have a stony clay loam surface layer in a small acreage of the survey area. Their depth to bedrock generally ranges from 22 to 40 inches. They are normally free of lime, but in some places calcium carbonate has accumulated immediately below the subsoil.

These soils take in water readily and have good moisture-storage capacity. Their supply of organic matter is good and their natural fertility is high. Annual precipitation is 18 to 24 inches, and the frost-free period is slightly more than 95 days.

The Alder soils have thicker and darker colored surface and subsurface layers than the Absarokee soils. They are generally less deep to bedrock than the Teton soils and contain more clay, particularly in their subsoil.

Alder clay loam, 2 to 8 percent slopes (An).—This soil occurs on gently rolling plains of the uplands. It has a profile like the one described as representative of the Alder series. A few cobblestones and pebbles are on the surface in some places.

Included in areas mapped as this soil are areas of Maginnis channery clay loam that are less than 2 acres in size and may amount to as much as 2 percent of any mapped area. This Maginnis soil is shallow over bedrock.

This is a productive soil that is used mainly for winter wheat, but some hay is also grown. Only the smaller, less accessible areas are in native range. Tilth is generally good. The surface layer is easily tilled and provides a good seedbed. Because the growing season is relatively short, timely farm operations are needed. Both water and wind erosion are likely in unprotected areas. (Capability unit IIIe–1, dryland; Silty range site, 20 to 24 inches precipitation)

Alder clay loam, 8 to 15 percent slopes (Ao).—This soil is on moderately steep edges of the upland plains and on short slopes along drainageways that cross the plains. Its profile is similar to the one described as representative of the Alder series except that the depth to bedrock ranges from about 20 inches on the upper slopes to about 40 inches on the lower slopes. Some areas are moderately eroded.

Included on the narrow crests of slopes in areas mapped as this soil are areas of Maginnis channery clay loam that are less than 1 acre in size. These inclusions are droughty and are low in productivity.

This soil is best used for hay or pasture. Because runoff is rapid, water erosion is a very serious problem in cultivated fields. Firmly anchored, living plants provide the easiest and best protection. (Capability unit IVe–1, dryland; Silty range site, 20 to 24 inches precipitation)

Alder stony clay loam, 8 to 15 percent slopes (Ap).—This moderately steep soil occurs with Alder clay loam in small areas that have a thin layer of stony alluvium covering the surface. Some of these areas are below dikes of igneous rock. Both igneous rock and sandstone are on the surface and in the profile.

Included on ridges and knolls in areas mapped as this soil are small areas of Maginnis channery clay loam.

This stony, clayey soil is not suitable for regular cultivation. It is well suited to range and produces good yields of forage under good management. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Alder-Maginnis channery clay loams, 2 to 8 percent slopes (Ar).—This complex consists of small, rolling areas of Alder and Maginnis soils that are so intermingled that they cannot be shown separately on the soil map. These areas occur closely with larger areas of Alder clay loam. The Alder soils make up 50 to 70 percent of each mapped area, and Maginnis channery clay loam makes up the rest. The Maginnis channery clay loam occurs on knolls and rises, generally in areas less than 2 acres in size. Its surface layer is thicker and darker colored than is typical of the Maginnis soils. The Alder soils occur on side slopes that surround the knolls and rises. They are less deep than is typical of the Alder series. In some places they have shale particles and hard fragments of sandstone scattered on the surface and throughout the profile. The sandstone fragments are 1 to 3 inches across.

The Alder soils in this complex are productive and are suited to hay, small grain, and pasture. Because they have medium runoff, they are susceptible to water erosion if they are not protected. The Maginnis channery clay loam is droughty. Its yields are fairly low. Because the growing season is short, timely farm operations are needed.

(Alder part: capability unit IIIe–1, dryland; Silty range site, 20 to 24 inches precipitation. Maginnis part: capability unit IVe–6, dryland; Silty range site, 20 to 24 inches precipitation)

Alder-Maginnis complex, 8 to 35 percent slopes (As).—This complex consists of Alder soils and Maginnis soils that are so intermingled that they cannot be shown separately on the soil map. The Alder soils are moderately deep clay loams, and the Maginnis soils are shallow and channery. These soils occur in hilly and sharply rolling areas below and adjoining soils on gently rolling upland plains.

The Maginnis soils make up 20 to 50 percent of this complex, and the Alder soils make up 50 to 80 percent. The Maginnis soils are on the crests, ridges, and knolls. Except for a darker colored surface layer, they are like the soil described for the Maginnis series. The Alder soils occur on the side slopes below the crests, knolls, and ridges. In this complex they are shallower than typical Alder soils, and in some parts of the complex they are channery. In other respects, their profile is like the one described as representative of the Alder series.

The soils of this complex are too steep and too dissected by drainageways for regular cultivation. Although runoff is rapid, erosion is not likely if the cover of range plants is good. Under good management, the Alder soils produce good yields of forage that are higher than those on the Maginnis soils. (Alder part: capability unit VIe–1; Silty range site, 20 to 24 inches precipitation. Maginnis part: capability unit VIe–5; Shallow range site)

Arvada Series

The Arvada series consists of shallow, light-colored soils that have a slightly to moderately alkaline subsoil with a claypan. These soils are closely associated with the Laurel and Beckton soils on nearly level to gently sloping stream terraces and fans, on swales of high benches, and, to a lesser extent, on uplands. They developed under a sparse cover consisting of mid grasses and some forbs.

The surface layer is loam in most places. It is grayish brown or light brownish gray, has platy structure, and is less than 4 inches thick. The subsoil consists of grayish-brown, alkaline clay and is about 8 inches thick. It has columnar structure in the upper part and blocky structure in the lower part. The parent material is clay loam or clay that is lighter colored than the surface layer and subsoil and is specked and streaked with salts.

The surface layer ranges from 1 to 4 inches in thickness and from loam to heavy clay loam in texture. The subsoil is 6 to 20 inches thick.

These soils take in water very slowly. They are low in organic-matter content. Their alkaline claypan subsoil is not favorable for good root growth.

The Arvada soils have a lighter colored, thinner surface layer than the Beckton soils.

Most of the acreage in Arvada soils is not cultivated, for these soils are best suited to pasture or to native range.

Arvada-Beckton cobbly clay loams (0 to 2 percent slopes) (At).—This complex consists of Arvada and Beckton soils that are mapped together because they are so intermingled that they cannot be shown separately on the soil map. These soils are in low or depressional areas on the high benches north and west of Arrow Creek. They occur with large areas of Danvers cobbly clay loam.

Each mapped area of this complex consists of 55 to 65 percent Arvada cobbly clay loam and 30 to 40 percent Beckton cobbly clay loam. The Arvada soil is slightly lower than the Beckton soil. Except for the cobblestones on the surface, it is like the soil described as representative of the Arvada series. The Beckton soil has a cobbly clay loam surface layer, contains accumulated lime in the lower part of the subsoil, and is less alkaline throughout than is typical of the Beckton soils.

Included in the areas mapped as this complex are bare spots of Laurel clay loam that are 1 to 4 feet wide. These spots make up about 5 percent of any mapped area.

The soils of this complex are best used for hay, pasture, or native range. The Beckton soil supports a good stand of grasses and produces fair yields of small grain and hay. Because the Arvada cobbly clay loam is shallow and slowly permeable, it supports only a sparse cover of grasses and produces low yields of small grain and hay. For the complex as a whole, yields are moderately low. Under good management, the most desirable and highest producing range grasses can be maintained. (Arvada part: capability unit IVs–1, dryland; Dense Clay range site. Beckton part: capability unit IVs–1, dryland; Clayey range site, 15 to 19 inches precipitation)

Arvada-Beckton complex, saline (0 to 4 percent slopes) (Au).—In this complex the Arvada soils and Beckton soils are so intermingled that they cannot be shown separately on the soil map. They are nearly level and occur only with the Danvers and Judith soils that occupy high benches.

The soils of this complex are poorly drained, shallow to moderately deep, saline clay loams. They have a dense, salty subsoil that has a claypan and is mottled and discolored. More salt is near the surface in these soils than in the soils described as representative of the Arvada and the Beckton series. These soils are underlain by shale at a depth of 4 to 8 feet, and they have a perched water table. The Arvada soil generally is dominant in each mapped area. It is shallow and slightly lower than the Beckton soil.

The soils of this complex are too wet to be cultivated and are best suited to range or pasture. They support a good cover of water-tolerant and salt-tolerant plants. Under good management, the most desirable grasses can be maintained. (Capability unit VIs–4; Saline Subirrigated range site)

Arvada-Laurel complex (0 to 8 percent slopes) (Av).—This complex is on stream terraces and fans. It consists of about 50 to 70 percent Arvada clay loam, about 20 to 40 percent Laurel clay loam, and about 10 percent Beckton loam. The Arvada and Beckton soils are in grass and the Laurel soils are in almost bare depressions, which are 1 to 8 feet across.

The Arvada and Laurel soils in this complex have profiles like those described for their series, but the Beckton soil has a lighter colored surface layer than is typical of its series.

The soils of this complex are best used for pasture or range. Because it has a high content of salt, a high dispersion rate, and little organic matter, Laurel clay loam is not suitable for cultivation and produces only a very small amount of forage. Because the Arvada soil is shallow and

slowly permeable, it normally produces low yields of cultivated crops and forage. Where flood irrigation is feasible, however, yields are increased. (Arvada part: capability unit IVs–1, dryland; Panspots range site. Laurel part: capability unit VIIs–5; Panspots range site)

Arvada-Terrad clays (2 to 8 percent slopes) (Aw).—This complex is made up of Arvada and Terrad clays that are so intermingled that they cannot be shown separately on the soil map. These soils occur on gently rolling uplands, in swales, and on fans.

The Arvada soil, occupying 30 to 60 percent of the complex, is in depressions. It formed in reddish-colored, finer textured material than the soil described as representative of the Arvada series. The Terrad clay makes up 30 to 50 percent of most mapped areas. In some places the profile of this soil is similar to the one described for the Terrad series, but in other places it contains more clay and has a thinner surface layer than is typical of the Terrad soils.

Included in areas mapped as this complex are areas of claypan soils that have a moderately thick surface layer and make up 5 to 10 percent of the acreage. Also included are spots of Laurel soils that make up 5 to 10 percent of the complex.

Because the soils of this complex are very slowly permeable, they are not suitable for cultivation. Their plant cover varies but is generally sparse. These soils produce moderately low yields of forage and are damaged by trampling if grazed when wet. (Capability unit VIe–8; Dense Clay range site)

Ashuelot Series

The Asheulot series consists of dark-colored, gravelly loams that are underlain by lime-cemented gravel at an average depth of 6 inches. These soils occur with the Judith soils on high benches and are mostly in the area south of Ackley Lake and about 4 miles southwest of Hobson. They developed under a cover of mid grasses.

The surface layer consists of dark grayish-brown gravelly loam about 4 inches thick. It grades to lighter colored, strongly calcareous gravelly loam that is underlain by a lime-cemented layer at a depth of no more than 20 inches. The very gravelly loamy material from which these soils developed was deposited by former streams flowing from the Little Belt Mountains.

Generally, the lime-cemented, gravel layer is at a depth of 4 to 10 inches, but in a few spots it is at the surface, and in some places it is at a depth of 20 inches. This cemented layer is 4 to 8 inches thick. It is weakly to strongly cemented, but has cracks a foot to a few feet apart.

These soils take in water readily but have low moisture-storage capacity. They have a moderately low supply of organic matter.

The lime-cemented gravel in the Ashuelot soils distinguishes them from the Utica and Judith soils.

Ashuelot gravelly loam (0 to 4 percent slopes) (Ax).—This soil occupies nearly level to gentle slopes on benches. It is in areas generally less than 60 acres in size. Except for depth, its profile is like the one described as representative of the Ashuelot series. Depth to the lime-cemented layer generally is less than 10 inches.

Included in swales in areas mapped as this soil are small areas of Judith gravelly clay loam that make up less than 10 percent of any mapped area.

Because this soil is shallow, low in organic-matter content, and high in gravel content, it is not suitable for cultivation. Its best use is range, but only moderately low yields of forage can be expected. The most desirable grasses can be maintained by good range management. (Capability unit VIs–3; Shallow range site)

Bainville Series

The Bainville series consists of light-colored loams that are underlain by soft bedrock at a depth of about 16 inches. These soils occur in small areas in a few parts of the rolling uplands northeast of Geyser. They developed under a cover of mid grasses.

The surface layer is light brownish gray, is about 6 inches thick, has weak, granular structure, and is easily worked. It is underlain by a subsoil of pale-yellow, strongly calcareous, massive loam that is about 8 to 10 inches thick and grades to thinly stratified layers of soft sandstone, siltstone, and shale. The depth to bedrock ranges from 1 to 2 feet.

These soils take in water fairly well but have moderately low moisture-storage capacity. They are low in organic-matter content.

The Bainville soils contain less clay than the Midway soils and are deeper to bedrock.

Bainville loam (4 to 15 percent slopes) (Ba).—This soil occurs on knolls and side slopes of the rolling uplands. Its profile is like the one described as representative of the Bainville series.

Included in areas mapped as this soil are areas of Midway clay loam that are less than 1 acre in size and make up less than 2 percent of any mapped area.

This soil is droughty, is low in organic-matter content, and produces low yields. Under cultivation, it erodes easily if it is not protected. Some areas are cultivated the same way as are adjacent larger areas of Winifred soils. Most of this soil is in native range or pasture, but forage yields are only moderate. (Capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Beckton Series

In the Beckton series are soils that have a moderately thick loam or clay loam surface layer and a moderately alkaline subsoil with a claypan. These soils are on terraces and high benches, where they occur as relatively pure areas of Beckton soils and in complexes with the Arvada, Savage, and Danvers soils. They developed under a dense cover of mid grasses.

Beckton loam is the most representative soil of this series. Its surface layer is about 6 inches thick. The upper part is dark grayish brown and generally has very weak, blocky structure, and the lower part is light grayish brown and has platy structure. The subsoil is dark grayish brown and is about 6 inches thick. It has columnar structure in the upper part and blocky structure in the lower. This layer grades to light olive-brown clay in which the salts and lime have accumulated.

The surface layer ranges from 4 to 8 inches in thickness. In some areas the subsoil is only slightly alkaline. The

accumulated lime occurs above the accumulated salts in some places and with them in others.

These soils take in water slowly and are well drained to moderately well drained. They have only a moderate supply of organic matter. The claypan subsoil and the accumulated salts restrict the growth of roots. Crop yields are fair to moderately low.

The Beckton soils have a thicker, darker colored surface layer than the Arvada soils.

Beckton loam (0 to 2 percent slopes) (Bb).—This soil occurs in small areas on low terraces. Its profile is like the one described as representative of the Beckton series.

Included in areas mapped as this soil are spots of Arvada soils that make up less than 10 percent of any mapped area.

Some of this soil is cultivated, and some is in native range. Because permeability is slow and the root growth is restricted, only moderately low yields of crops can be expected. Unprotected areas of this soil are susceptible to wind erosion. (Capability unit IIIs–1, dryland; Silty range site, 15 to 19 inches precipitation)

Beckton-Arvada clay loams (0 to 8 percent slopes) (Bc).—This complex consists of Beckton and Arvada soils that are in slight depressions on a few fans and stream terraces. These soils are so intermingled that they cannot be shown separately on the soil map. They have profiles like those described for the Beckton and Arvada series.

The Beckton soil makes up 60 to 70 percent of this complex; the Arvada soil, 20 to 30 percent; and bare spots of Laurel clay loam, 5 to 10 percent of most mapped areas. The Beckton and Arvada soils have a clay loam surface layer and a claypan in the subsoil. The surface layer of the Beckton soil is moderately thick and that of the Arvada soil is shallow. The Arvada soil is in slight depressions.

Most of the acreage of this complex is in native range, but small areas are cultivated the same way as are adjacent, larger areas of Winifred and Savage soils. Under good range management, forage yields are fair to good. Because the soils in this complex are low in organic-matter content, are slowly permeable, and have rapid runoff, they produce fairly low yields of cultivated crops. They erode easily if they are not protected. (Beckton part: capability unit IIIs–1, dryland; Clayey range site, 15 to 19 inches precipitation. Arvada part: capability unit IVs–1, dryland; Dense Clay range site)

Beckton-Danvers clay loams (0 to 4 percent slopes) (Bd).—Beckton clay loam and Danvers clay loam are mapped together as a complex because they are so intermingled that they cannot be shown separately on the soil map. They occur in the north-central part of the survey area on high benches along Davis Creek.

Beckton clay loam amounts to 50 to 70 percent of this complex, and Danvers clay loam amounts to 30 to 50 percent. Both soils have a few pebbles on the surface and throughout the profile. The Beckton soil is less alkaline than the soil described as representative of the Beckton series, but lime has accumulated in the lower subsoil. The Danvers soil is similar to the soil described for the Danvers series.

Most of this complex is used to produce small grain. On the whole the complex is productive, but the slowly permeable Beckton soil is less productive than the Danvers soil and makes a less desirable seedbed. Also, in some places plowing turns up the clay subsoil material in the thin Beckton soil. Both soils are susceptible to wind erosion if they are not protected. (Beckton part: capability unit IIIs–1, dryland; Clayey range site, 15 to 19 inches precipitation. Danvers part: capability unit IIc–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Beckton-Savage complex (0 to 2 percent slopes) (Bf).—This complex consists of Beckton and Savage soils that are mingled so closely that they cannot be shown separately on the soil map. It occurs only on a few terraces in the east-central part of the survey area.

The Beckton soils occupy 50 to 70 percent of the complex; the Savage soils, 30 to 40 percent; and spots of Arvada clay loam, 5 to 10 percent. The Arvada soil has a thin clay loam surface layer and a claypan in the subsoil. The Beckton soils are similar to the soil described for the Beckton series except that they have a loam and clay loam surface layer and less clay in the subsoil. The Savage soils are mostly silty clay, and they are finer textured throughout than is typical of Savage soils.

This complex is suitable for hay, small grain, and pasture. Under good management, the Beckton and Savage soils are fairly productive. Yields are low on the spots of Arvada clay loam. Because of their clay subsoil, the Beckton soils are less permeable to water and roots than the Savage soils and are, therefore, less productive. The Savage silty clay is somewhat difficult to work and can be tilled only if the moisture content is good. The granular surface layer of both the Savage and Beckton soils is highly susceptible to wind erosion where it is not protected. Stubble mulch and wind strips provide adequate protection. (Beckton part: capability unit IIIs–1, dryland; Clayey range site, 15 to 19 inches precipitation. Savage part: capability unit IIe–3, dryland; Clayey range site, 15 to 19 inches precipitation)

Big Timber Series

The Big Timber series consists of dark-reddish clay loams that are underlain by bedrock at a depth of about 15 inches. These soils occur on steep slopes in the foothills where sandstone crops out in most places. They developed under a cover of mid grasses.

These soils are calcareous throughout. They have a granular, weak-red to reddish-brown surface layer that is about 3 inches thick. The subsoil is weak-red to reddish-brown clay loam about 12 inches thick. Generally, it has weak, blocky structure and contains fragments of shale and sandstone in the lower part. The subsoil merges with clay loam parent material that weathered from reddish-colored shale and sandstone.

The surface layer ranges from 2 to 4 inches in thickness. In some places layers of clay have weathered from the shale strata. Depth to the bedrock ranges from 12 to 18 inches.

These soils take in water moderately slowly and have rapid runoff. Their moisture-storage capacity is moderate. The supply of organic matter is moderately low.

The Big Timber soils have a thinner, lighter colored surface layer than the Darret soils and a less clayey subsoil. Also, they are shallower to bedrock.

In this survey area, the Big Timber soils are mapped only with the Cheadle soils and Rock outcrop.

Blaine Series

In the Blaine series are dark-colored soils that are underlain by igneous rock at an average depth of 24 inches. These soils occur on rolling uplands. They developed under a dense cover of mid grasses.

Blaine stony loams are the most extensive and most representative soils of the series. They have a dark-gray surface layer that is about 3 inches thick and is free of lime. The subsoil is dark grayish-brown, blocky clay loam or light clay that is about 14 inches thick. This layer grades to gravelly clay loam that contains accumulated lime and merges with bedrock at a depth of about 24 inches. The parent material is gravelly clay loam that weathered mostly from igneous rock.

The surface layer is loam or stony loam. The subsoil ranges from clay loam to light clay in texture and generally from 15 to 20 inches in thickness. Depth to bedrock ranges from 18 to 60 inches but generally it is less than 24 inches.

These soils take in water readily and have fair to good moisture-storage capacity. Runoff is medium on the moderate slopes and rapid on the stronger slopes. The supply of organic matter is moderate.

The Blaine soils are distinguished from the nearly black, lime-free Woodhurst soils by their lighter colored surface layer and the layer of accumulated lime. Their strong, blocky subsoil distinguishes them from the associated Spring Creek soils, which have a moderate, granular subsoil.

Blaine-Spring Creek loams, 2 to 8 percent slopes (Bg).—This complex consists of Blaine loam and Spring Creek loam that are so closely intermingled that they cannot be shown separately on the soil map. These soils occur on gently rolling uplands.

The Blaine soil amounts to 75 to 80 percent of the complex, and the Spring Creek soil amounts to most of the rest. The Spring Creek soil is on knolls and complex slopes in areas that are less than 1 acre to 2 acres in size. It is somewhat similar to the soil described for the Spring Creek series, but it is nonstony and deeper (15 to 18 inches) to bedrock. The Blaine soil surrounds the knolls and complex slopes that are occupied by the Spring Creek soil. It is 18 to 24 inches to bedrock, which is shallower to rock than is typical of Blaine soils.

The Spring Creek soil is fairly droughty, but the Blaine soil can store a moderate amount of moisture. Under good management, these soils together produce fair to good yields of small grain or hay. Because slopes are moderate and the surface layer is granular, these soils are subject to both wind and water erosion if they are not protected. (Capability unit IIIe–4, dryland; Silty range site, 15 to 19 inches precipitation)

Blaine-Spring Creek stony loams (8 to 35 percent slopes) (Bh).—This complex consists of Blaine soils and Spring Creek soils that are so intermingled that they cannot be shown separately on the soil map. These soils are on hilly uplands east of the Highwood Mountains and north of Arrow Creek, and they occur in a few places in the central part of the survey area.

The Blaine soil makes up 40 to 60 percent of each mapped area, and the Spring Creek soil, 30 to 50 percent. Rock outcrop makes up 5 to 10 percent of most mapped areas and is on knobs and ridges. Spring Creek stony loam occupies prominent knobs and ridges and is surrounded by the Blaine soil on the side slopes. The Blaine soil is similar to the soil described as representative of the Blaine series. It has a varying amount of stones and pebbles on the surface and through the soil.

The soils in this complex are best suited to range and, under good management, produce good yields of forage. Because the Blaine soil is stony and is in small, irregularly shaped areas, it is not suitable for regular cultivation. The Spring Creek soil is too shallow, stony, and droughty for cultivation. (Blaine part: capability unit VIs–2; Silty range site, 15 to 19 inches precipitation. Spring Creek part: capability unit VIIs–2; Shallow range site)

Blythe Series

The Blythe series consists of soils that have a thick, black loam surface layer and a claypan in the subsoil. These soils occur on the gently and moderately sloping uplands, fans, and stream terraces. They are in the foothills south of the Highwood Mountains, where they developed under a dense cover of mid and tall grasses.

The surface layer is loam about 14 inches thick. In the upper part it is dark gray or very dark gray and has granular structure; in the lower part it is gray and has fine, blocky structure. The surface layer is underlain by a claypan that is 15 inches thick and breaks into columns, prisms, and blocks. Generally, calcium carbonate and gypsum have accumulated in the lower part of the subsoil. On the uplands the parent material is light-colored clay that weathered in place from shale, and on the fans it is light-colored clay alluvium.

The surface layer ranges from 10 to 18 inches in thickness. On the uplands shale and sandstone are at a depth of 20 to 40 inches, but on the fans depth to bedrock is more than 5 feet.

These soils are moderately well drained or well drained and have good moisture-storage capacity. They have a good supply of organic matter and are easily worked. The subsoil, however, is slowly to very slowly permeable to water and roots.

The Blythe soils have a thicker, darker colored surface layer than the Beckton soils. Other than gypsum, Blythe soils lack the salts that occur in the subsoil of the Beckton soils.

Blythe loam, 2 to 4 percent slopes (Bk).—This soil occurs on gently sloping fans and terraces. It has a profile like the one described as representative of the Blythe series. In some places on the terraces, the lower part of the subsoil is slightly mottled. This mottling indicates restricted drainage.

Included on the upper part of some fans in areas mapped as this soil are areas less than 2 acres in size that have slopes of 5 or 6 percent. Also included are a few spots that have a thin surface layer and amount to less than 5 percent of any mapped area.

This soil is suited to hay, small grain, and pasture. Except for the few spots that have a thin surface layer, the soil is easily worked and produces well. Planting may be delayed in some areas where drainage is restricted. The granular surface layer is highly susceptible to wind erosion where it is not protected. (Capability unit IIIe–5, dryland; Silty range site, 20 to 24 inches precipitation)

Blythe loam, 4 to 8 percent slopes (Bm).—This soil is on moderately sloping fans and rolling uplands. Its profile is similar to the one described as representative of the Blythe series. On the uplands shale is at a depth of 20 to 40 inches and on the fans, it is at a depth of more than 5 feet.

Included in some areas mapped as this soil are small areas that have a thin surface layer. These areas make up 5 to 10 percent of some mapped areas.

Most of this soil is cultivated in the same way as are adjacent areas of Alder clay loam. The rest is in native range. Except for the thin spots, yields are good. Because of its slope and slow permeability, this soil is highly susceptible to water erosion. The granular surface layer is subject to wind erosion where it is not protected by a plant cover or where conservation practices are not applied. (Capability unit IIIe–5, dryland; Silty range site, 20 to 24 inches precipitation)

Bowdoin Series

The Bowdoin series consists of deep, dark-colored, imperfectly drained soils that are calcareous. These soils formed in clay or silty clay. They occur mainly in the outer parts of wide valleys. In a few places they are along intermittent streams in narrow valleys. The native vegetation consists mainly of water-tolerant grasses, but a few sedges grow in some places.

The surface layer is very dark gray and about 10 inches thick. It is granular in the upper part and prismatic or blocky in the lower. The subsoil consists of very dark gray clay that has prismatic or blocky structure and is about 20 inches thick. The lower part of the subsoil is mottled with gray and brown. The underlying material is dense clay.

The surface layer ranges from silty clay to silty clay loam, but only silty clay is mapped in this survey area. Generally, the water table fluctuates between depths of 2½ and 5 feet.

These soils are slowly permeable or very slowly permeable. They have a good supply of organic matter.

The Bowdoin soils have a darker colored subsoil than the Promise soils, and they have a high water table that the well-drained Promise soils lack.

Bowdoin silty clay, low clay variant (0 to 2 percent slopes) (Bo).—This is the only Bowdoin soil mapped in the survey area. Most of the acreage is in native plants and is used for pasture and hay, but a small acreage is used to produce small grain. Because of its high-clay content and high water table, this soil is difficult to work. It provides good pasture if it is irrigated. Overflow is a problem in some places. (Capability unit IIIw–1, dryland; Subirrigated range site)

Bridger Series

The Bridger series consists of deep, black loams and stony loams that occur on foot slopes and fans in the foothills of the survey area. These soils developed under a dense cover of mid and tall grasses.

The surface layer is dark-gray loam or stony loam that has granular or blocky structure and is about 7 inches thick. The subsoil is more clayey than the surface layer and is about 20 inches thick. It is brown, noncalcareous, and blocky. The subsoil grades to strongly calcareous clay loam or gravelly clay loam in which lime has accumulated. The parent material is gravelly loamy alluvium that washed from the uplands.

The surface layer ranges from 6 to 10 inches in thickness and is stony loam in most places. The subsoil ranges from clay loam to light clay. In places there are weak to strong accumulations of calcium carbonate at a depth of 20 to 30 inches. The content of gravel, cobblestones, and stones ranges from a trace to as much as 30 percent.

These soils take in water readily, are well drained, and have good moisture-storage capacity. They have a good supply of organic matter.

The Bridger soils have a thinner surface layer and a more clayey subsoil than the Adel soils and generally contain more coarse fragments in the lower part of the subsoil.

Bridger loam, 2 to 4 percent slopes (Bp).—This soil occurs in small areas on gently sloping fans and terraces. Except that it contains fewer coarse fragments, its profile is similar to the one described as representative of the Bridger series.

Included in areas mapped as this soil on the higher parts of some fans are areas less than 1 acre in size that have slopes of 5 or 6 percent.

This soil is used mainly to produce hay. Much of it is irrigated. Although the growing season is short, this soil produces good yields of small grain if farm operations are timely. It is easily tilled, and its surface soil provides a good seedbed, but in unprotected cultivated areas, water erosion is a slight hazard. (Capability unit IIc–1, dryland, and IIIe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Bridger loam, 4 to 15 percent slopes (Br).—This soil occupies short foot slopes and sloping fans below the uplands. Its profile is like the one described as representative of the Bridger series.

Included in areas mapped as this soil on the higher parts of the fans are small areas of cobbly soils.

Most of this soil is used to produce hay. A part of the acreage is irrigated, but careful management is needed for an even distribution of water. Because it has stronger slopes, this soil has more rapid runoff than Bridger loam, 2 to 4 percent slopes, and is more susceptible to erosion if it is not protected. (Capability unit IVe–1, dryland, and IVe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Bridger stony loam (4 to 35 percent slopes) (Bs).—This soil occurs on sloping fans and steep foot slopes below the uplands. Most of it is on fans that have slopes of 4 to 15 percent. It has a profile that is more stony and cobbly throughout than the profile described as representative of the Bridger series. The amount of cobblestones and stones in the surface layer varies from about 5 percent on the lower parts of fans to as much as 25 percent on the higher parts.

This soil is too stony for cultivation. Under good management, it produces good yields of forage for grazing. (Capability unit VIs–1; Silty range range site, 20 to 24 inches precipitation)

Castle Series

The Castle series consists of very dark colored clayey soils that are underlain by clay shale at an average depth of 28 inches. These soils occur only in a few places in the foothills of the Little Belt Mountains. They developed under a dense cover of mid grasses.

These soils are calcareous clay throughout. The very dark grayish-brown surface layer is about 8 inches thick and has granular structure in the upper part and weak blocky structure in the lower part. It grades to a very dark gray subsoil in which some calcium carbonate has accumulated at a depth of 12 to 18 inches. The subsoil merges with the underlying shale at a depth of 20 to 40 inches. The parent material is clay that weathered in place from the shale.

In some places the surface layer consists of alluvium of clay loam texture.

These soils have a good supply of organic matter, but they absorb water very slowly because the content of clay is high. Cracks 1 to 2 inches wide form when the soils contract as they dry, but the cracks close when the soils are wet again.

The Castle soils have a darker colored and thicker surface layer than the Pierre soils.

Castle clay, 4 to 15 percent slopes (Ca).—This soil occurs on rolling uplands. Its profile is like the one described as representative of the Castle series. Depth to shale ranges from about 20 inches on the knolls and ridges to about 40 inches on the side slopes.

Included on short fans in areas mapped as this soil are areas that have a clay loam surface layer. These inclusions make up as much as 15 percent of some mapped areas.

This soil is used mostly for pasture and hay and is best suited to those uses. Unprotected areas are highly susceptible to water erosion because permeability is slow and runoff is rapid. (Capability unit IVe–3, dryland; Clayey range site, 20 to 24 inches precipitation)

Castle clay, 15 to 35 percent slopes (Cb).—This soil occupies small areas on steeply rolling or hilly uplands. Its profile is similar to the one described as representative of the Castle series. Ledges of limestone and sandstone crop out and make up less than 5 percent of some mapped areas.

This soil is too steep for cultivation and is used for native range. It produces good yields of forage under good management. Trampling of livestock causes considerable damage, particularly when the soil is muddy. (Capability unit VIe–2; Clayey range site, 20 to 24 inches precipitation)

Castle complex (15 to 35 percent slopes) (Cc).—This complex occurs on steep, hummocky, or hilly slumps in landslide areas. The slides occurred in the clay shale on which the Castle soils normally form. Castle soils make up 70 to 80 percent of the complex. The rest is varying proportions of reddish clay loam and small outcrops of sandstone, limestone, and igneous rock. The clay loam developed from soft shale and sandstone, and the outcrops occur with small areas of Cheadle, Duncom, and Spring Creek soils. Small springs, seeps, and drainageways are common.

This complex of soils is too steep, rough, and stony for cultivation. Under good range management, it produces good yields of forage for grazing. (Capability unit VIe–2; Clayey range site, 20 to 24 inches precipitation)

Chama Series

The Chama series consists of moderately dark colored clay loams that are underlain by soft bedrock at a depth of about 30 inches. These soils are on rolling uplands in the southeastern corner of the survey area. The native vegetation consists of mid grasses.

The surface layer is dark grayish brown and about 5 inches thick. It has weak granular to weak platy structure and is easily worked. This layer is underlain by dark grayish-brown clay loam that is about 4 inches thick and has prismatic or blocky structure. The lower part of the subsoil is pale brown or light gray and strongly calcareous. It merges with soft bedrock at a depth of about 30 inches. The parent material is clay loam that weathered in place from soft shale.

The surface layer ranges from 3 to 5 inches in thickness in undisturbed areas and generally is calcareous in cultivated areas. The upper part of the subsoil is 3 to 5 inches thick. The depth to shale ranges from 2 to 4 feet.

These soils have moderate to moderately slow permeability, good moisture-storage capacity, high natural fertility, and a fairly low supply of organic matter.

The Chama soils contain a greater amount of calcium carbonate than the Straw and Bainville soils. They have a shale substratum that the Straw soils lack, and they are darker colored than the Bainville soils.

Chama clay loam, 4 to 8 percent slopes (Cd).—This soil occurs on rolling uplands. Its profile is like the one described as representative of the Chama series.

Included on some of the knolls in areas mapped as this soil are very small areas of Midway clay loam.

This soil is fairly productive, and most of its small acreage is cultivated. Tillage is easy, and the surface layer provides a good seedbed. Because this soil is sloping and moderately slow in permeability, water erosion is likely. Wind erosion is less likely than water erosion. Conservation practices are needed to conserve moisture and to control erosion. (Capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Chama-Midway clay loams, 4 to 8 percent slopes (Cf).—This complex consists of Chama clay loam and Midway clay loam that are so intermingled that they cannot be shown separately on the soil map. It occurs on rolling uplands.

The Midway clay loam, a light-colored soil that is shallow over shale, has a profile similar to the one described as representative of the Midway series. It occurs on the knolls and rises and makes up 20 to 40 percent of each mapped area. The Chama clay loam makes up the rest and is on side slopes and other areas that surround the knolls. Its profile is like the one described as representative of the Chama series.

The Chama clay loam is fairly productive and is suitable for hay, small grain, and pasture. Because runoff is medium, erosion is likely in unprotected areas. The Midway clay loam is droughty, low in organic-matter content, and susceptible to erosion. It is best used for pasture and hay

where that use is feasible. (Chama part: capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation. Midway part: capability unit IVe–6, dryland; Clayey range site, 15 to 19 inches precipitation)

Chama-Midway clay loams, 8 to 15 percent slopes (Cg).—This complex consists of areas of Chama clay loam and Midway clay loam that are so intricately mixed that they cannot be shown separately on the soil map. It occupies moderately steep slopes on rolling uplands.

The Midway clay loam makes up 30 to 40 percent of this complex, and the Chama soil makes up the rest. The Midway soil occurs on knolls and ridges and is shallow and light colored. It has a profile like the one described as representative of the Midway series. The Chama clay loam occurs between ridges and on side slopes that surround knolls. It is shallower to shale than the soil described for the Chama series.

This complex is in cultivated crops and native range. The Chama clay loam is fairly productive and is best used for pasture or hay. Because of the moderately steep slopes and rapid runoff, water erosion is a serious problem where firmly anchored living plants have been destroyed by cultivation. Because it is shallow and moderately steep, the Midway soil is best protected by permanent vegetation. (Chama part: capability unit IVe–2, dryland; Clayey range site, 15 to 19 inches precipitation. Midway part: capability unit VIe–6; Clayey range site, 15 to 19 inches precipitation)

Cheadle Series

The Cheadle series consists of dark colored or very dark colored soils that generally are shallow over sandstone. These soils occur on moderate to very steep slopes in the uplands of the foothills, and, to a lesser extent, in the plains section of the survey area. They developed under vegetation consisting mostly of midgrasses.

Cheadle stony loam is the most extensive and most representative Cheadle soil in the survey area. Its surface layer is dark grayish brown to very dark grayish brown, is about 4 inches thick, and is free of lime. It has weak, fine, granular structure. It is underlain by grayish-brown or dark grayish-brown stony loam that is about 8 inches thick and is calcareous or noncalcareous. This layer rests on broken or shattered sandstone.

The Cheadle soils in this survey area have a surface layer of loam, stony loam, and channery loam. Depth to bedrock ranges from 8 to 24 inches but is most commonly less than 18 inches. Generally, some calcium carbonate has accumulated on sandstone fragments above the bedrock or on the upper layers of the bedrock.

These soils take in water readily, but they are droughty because they are shallow and have low moisture-storage capacity. Their thin surface layer contains only a moderate supply of organic matter.

The underlying sandstone from which the Cheadle soils formed distinguishes them from the Duncom soils, which are underlain by limestone, and the Spring Creek soils, which are underlain by igneous rock. The Cheadle soils lack the thick, blocky subsoil of the Teton soils.

Cheadle-Big Timber-Rock outcrop complex (15 to 35 percent slopes) (Ch).—This complex occupies broken slopes on the edge of plateaus and on canyon walls in the lower foothills. It consists mostly of Cheadle stony loam and Big Timber clay loam. These soils occur as lateral bands on steep and very steep slopes that are broken by ledges of sandstone.

Cheadle stony loam makes up 40 to 70 percent of this complex; Big Timber clay loam, 10 to 30 percent; and Rock outcrop, 20 to 50 percent. Generally, the Cheadle soil occurs as lateral bands, and the Big Timber soil is on concave slopes. The Cheadle soil is 8 to 12 inches thick, which is thinner than typical Cheadle soils. The Big Timber soil has a profile like the one described as typical of the Big Timber series.

Commonly included at the base of slopes is Twin Creek loam. It makes up 10 percent of most mapped areas. Darret clay loam amounts to 5 percent of some mapped areas.

The soils in this complex are so steep and broken that they cannot be cultivated, but they are suitable for range. They are droughty because they are shallow and have rapid runoff. Under good management, this complex as a whole produces fair yields of forage. The Twin Creek and Darret soils can produce good yields of forage. (Cheadle part: capability unit VIIs–2; Thin Breaks range site, 15 to 19 inches precipitation. Big Timber part: capability unit VIe–6; Thin Breaks range site, 15 to 19 inches precipitation. Rock outcrop part: capability unit VIIIs–1; Thin Breaks range site, 15 to 19 inches precipitation)

Cheadle channery loam, 2 to 8 percent slopes (Ck).—This soil occurs on gently rolling uplands. Except for the channery loam surface layer, it has a profile like the one described as representative of the Cheadle series.

Generally, this soil is 10 to 20 inches deep. On the knolls and ridges it is shallower than in other places and contains more sandstone fragments in the surface layer.

Most of this soil is in native range, and some areas that were cultivated have reverted to grass. Because the soil is droughty, yields of small grain are low. Hay, pasture, or native range is the best use. Unprotected areas are susceptible to wind erosion. (Capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Cheadle channery loam, 8 to 15 percent slopes (Cm).—This soil occurs on knolls, on ridges, and in areas surrounding them. The knolls and ridges make up 40 to 50 percent of this soil. Except for depth, the soil has a profile similar to the one described as representative of the Cheadle series. Depth ranges from 10 to 14 inches on the knolls and ridges and 14 to 18 inches in the areas surrounding them.

Included on some ridges in areas mapped as this soil are small areas of Cheadle stony loam.

Because this soil is moderately steep and droughty, it is not suitable for regular cultivation. It is highly susceptible to water erosion where the firmly anchored living plants have been destroyed. Yields of small grain and hay are low, but those of grass are fair. (Capability unit VIe–6; Silty range site, 15 to 19 inches precipitation)

Cheadle loam, 2 to 8 percent slopes (Cn).—This soil occurs on gently rolling uplands. Except that it is nonstony and deeper to bedrock, this soil has a profile similar to the one described as representative of the Cheadle series. Depth to bedrock ranges from 15 to 24 inches.

This soil has fairly low moisture-storage capacity, but under good management it produces fair yields of small grain and hay. Because runoff is medium, water erosion

is likely in unprotected areas or where conservation practices are not applied. (Capability unit IIIe–4, dryland; Silty range site, 15 to 19 inches precipitation)

Cheadle loam, 8 to 15 percent slopes (Co).—This soil occurs on rolling uplands that have moderately steep slopes. Except that it is nonstony and deeper to bedrock, this soil has a profile similar to the one described as representative of the Cheadle series. Depth to bedrock generally is 15 to 24 inches.

Included on knolls in areas mapped as this soil are areas of Cheadle channery loam that are less than 15 inches deep. These inclusions make up as much as 10 percent of some mapped areas.

Because runoff is rapid, this soil is highly susceptible to water erosion if left without vegetative cover. It is best used for hay or pasture. (Capability unit IVe–5, dryland; Silty range site, 15 to 19 inches precipitation)

Cheadle stony loam (4 to 35 percent slopes) (Cp).—This soil occurs on moderately sloping plateaus, on edges of steep plateaus, and on steep side slopes of coulees. It has a profile like the one described as representative of the Cheadle series.

Included on steep slopes in areas mapped as this soil are small areas of sandstone outcrop that make up as much as 10 percent of some mapped areas.

This soil is too stony and too shallow for cultivation and is best used for grazing. Because it is droughty, yields of forage are lower than on deeper soils. Native range plants, however, can be maintained if management is good. (Capability unit VIIs–2; Shallow range site)

Cheadle-Rock outcrop complex (35+ percent slopes) (Cr).—This complex is on very steep, broken slopes on the edges of uplands, where it occurs with the Teton and other Cheadle soils.

The Cheadle soil makes up 40 to 60 percent of this complex; Rock outcrop makes up 30 to 50 percent; and Raynesford and Adel stony loams account for the rest. The Raynesford and Adel soils are at the base of slopes. The Cheadle soil has a stony loam surface layer and is shallower to bedrock than the Cheadle soil described as representative of the series.

The soils of this complex are suitable only for wildlife habitats and range. They produce only a small amount of forage in which ponderosa pine is commonly scattered. (Cheadle part: capability unit VIIs–2; Very Shallow range site. Rock outcrop part: capability unit VIIIs–1; Very Shallow range site)

Cheadle-Duncom-Rock outcrop complex (15 to 35 percent slopes) (Cs).—This complex occurs in mountainous areas of the foothills on steep slopes that are broken by ledges of sandstone and limestone. Igneous rock crops out in places.

Each mapped area of this complex consists of 50 to 70 percent Cheadle and Duncom stony loams; 15 to 25 percent Rock outcrop; 5 to 10 percent Teton and Skaggs soils; and small areas of Raynesford stony loam. The Cheadle and Duncom soils are between the ledges. They have profiles like the ones described as representative of the Cheadle and Duncom series. The Teton and Skaggs soils occur in small areas on concave slopes between the ledges. The Raynesford soil is at the base of slopes.

The soils of this complex are too steep, stony, and broken for cultivation. Under good range management, the native vegetation can be maintained and fair yields of forage produced. The Cheadle and Duncom soils are shallower and more droughty than the Teton and Skaggs soils and produce lower yields. (Cheadle and Duncom parts: capability unit VIIs–2; Thin Breaks range site, 20 to 24 inches precipitation. Rock outcrop part: capability unit VIIIs–1; Thin Breaks range site, 20 to 24 inches precipitation)

Clayey Alluvial Land (Ct)

This land type is on slopes of 2 to 15 percent below the rough breaks along Arrow Creek. It consists of deep, clayey, saline soils that occur on coalescing fans below areas of Lismas soils and of exposed clay shale. These saline soils are dominantly clayey throughout, but they contain lenses of fine sand and shaly and gravelly materials. In many small areas, 5 to 20 feet wide, highly dispersed soils support a sparse cover of vegetation. These areas make up 20 percent of some mapped areas. Sharp drainageways dissect Clayey alluvial land in places.

This land type is very slowly permeable because it is clayey and highly dispersed. Roots cannot penetrate deeply, and runoff is rapid. Organic-matter content is low. Vegetation is sparse in some places and moderately thick in others. Grasses that grow naturally are the most desirable and most productive, and they can be maintained by good range management. (Capability unit VIe–8; Dense Clay range site)

Cobbly Alluvial Land (Cu)

This miscellaneous land type is on slopes of 0 to 4 percent along major streams on narrow flood plains near the mountains. It consists of very cobbly and very gravelly sandy soils in narrow strips along the Judith River and smaller, swift-flowing streams. The surface layer has been darkened by an increase in organic matter. The soil material is dominantly sand and loamy sand, but it is stratified with loam and sandy loam. It is a possible source of clean sand suitable for concrete work.

This land type is too droughty and too cobbly for cultivation. It produces more forage for grazing than might be expected, but compared with other soils, its production is low. Grasses that grow naturally are the most productive and can be maintained by good range management. (Capability unit VIIs–3; Shallow to Gravel range site)

Colvin Series

The Colvin series consists of deep, dark-colored, poorly drained clay loams on nearly level to gently sloping terraces. The native vegetation is water-tolerant grasses and sedges.

These soils are strongly calcareous throughout. The granular surface layer is gray to very dark gray and about 10 inches thick. The light-colored subsoil is about 2 feet thick and, in the upper part, is faintly mottled with strong accumulations of calcium carbonate. At a depth of about 3 feet, the subsoil is underlain by pebbles mixed with material finer than sand. This material was deposited by former streams. Shale is at a depth of 6 feet or more.

The surface layer ranges from 6 to 15 inches in thickness. The water table fluctuates between depths of 3 and

5 feet. Depth to the gravelly material ranges from 2 to 5 feet.

The underlying impermeable shale causes the poor drainage in these soils. The supply of organic matter is good.

The distinct segregations of lime in the Colvin soils distinguishes them from the closely associated Lamoure soils.

Colvin-Lamoure clay loams (0 to 4 percent slopes) (Cv).—In this complex Colvin clay loam and Lamoure clay loam are mapped together because they are so intermingled that they cannot be shown separately on the soil map. Each of these soils have profiles that are typical of their respective series.

Generally, the Colvin soil is slightly higher than the Lamoure soil. Colvin clay loam makes up 40 to 60 percent of each mapped area, and Lamoure clay loam makes up the rest.

Most of this complex is in hay or pasture of native grasses and sedges that are tolerant of water, but the edges of some large areas are cultivated. These soils are suitable for cultivation. Because plants receive ample water through subirrigation, yields of forage are good. (Capability unit IIIw–1, dryland; Subirrigated range site)

Cowood Series

The Cowood series consists of gravelly, loamy, light-colored soils that are underlain by igneous bedrock at a depth of about 2 feet. These soils occur in the Highwood and the Little Belt Mountains on steep, wooded slopes that face north.

Underlying a thin layer of forest litter is a light brownish-gray, crumb surface layer about 6 inches thick. The very gravelly, grayish-brown subsoil has little or no structure and merges with bedrock at a depth of about 2 feet. The parent material is gravelly silt loam that weathered in place, or nearly in place, from igneous rock.

Depth to bedrock ranges from about 1 to 3 feet.

These soils are rapidly permeable and the bedrock under them has cracks through which some water filters and then seeps into local drainageways or adds to the ground water. Some tree roots also penetrate into the cracks and obtain moisture, though the moisture-storage capacity of the soil itself is low. Also low is the content of organic matter.

The Cowood soils lack the dark-colored surface layer and the accumulated lime of the Spring Creek soils.

Cowood stony loam (15+ percent slopes) (Cw).—This soil is on steep and very steep slopes that face north. Most of it is in the Highwood Mountains, but a small part is in the Little Belt Mountains. Except for depth, it has a profile like the one described as representative of the Cowood series. Depth to bedrock is 1 to 3 feet, but moisture penetrates to a depth of several feet because the bedrock is weathered and cracked.

Most of the native lodgepole pine still stands; only a small amount has been harvested for posts and poles. The trees and the forest litter help to control runoff and erosion and also to regulate the flow of streams and to replenish the supply of ground water. (Capability unit VIIs–6; no range site assigned)

Cowood-Rock outcrop complex (15+ percent slopes) (Cx).—This complex occurs in the Highwood Mountains on steep and very steep, broken slopes that face south. Cowood stony loam makes up 40 to 60 percent of the complex; Spring Creek stony loam, 10 to 20 percent; and outcrops of rock, 30 to 40 percent. The Cowood soil is in scattered patches of timber, the Spring Creek soil is in grass, and the outcrops consist of barren level rock, some of which has slipped. The Cowood stony loam is 1 to 2 feet deep, which is less than average for the Cowood soils.

The trees in this complex are dominantly lodgepole pine, and there is some scattered Douglas-fir, but timber is limited in amount and is difficult to harvest because of the rugged terrain. Also, areas of grass are somewhat inaccessible to livestock. The complex is used by wild game, however, and it can store a large amount of water that regulates the flow of streams and replenishes ground water. (Cowood part: capability unit VIIs–6; no range site assigned. Rock outcrop part: capability unit VIIIs–1; no range site assigned)

Danvers Series

The Danvers series consists of dark-colored clay loams that, at a depth of about 30 inches, are underlain by pebbles mixed with material finer than sand. These soils are on high benches in the plains of the survey area. They generally are nearly level and gently sloping but in some small areas slopes are as much as 15 percent.

The granular surface layer is gray to dark grayish brown and about 4 inches thick. It is underlain by grayish-brown, noncalcareous, heavy clay loam that is about 7 inches thick and has prismatic or blocky structure (fig. 7). This layer grades to gray or light-gray, strongly calcareous clay loam that, at a depth of 24 to 50 inches, merges with pebbles mixed with material finer than sand. Overlying the pebbles is parent material consisting of clay loam alluvium and some windblown material. In most places the pebbles are limestone, but those believed to have washed from the Highwood Mountains are igneous rock.

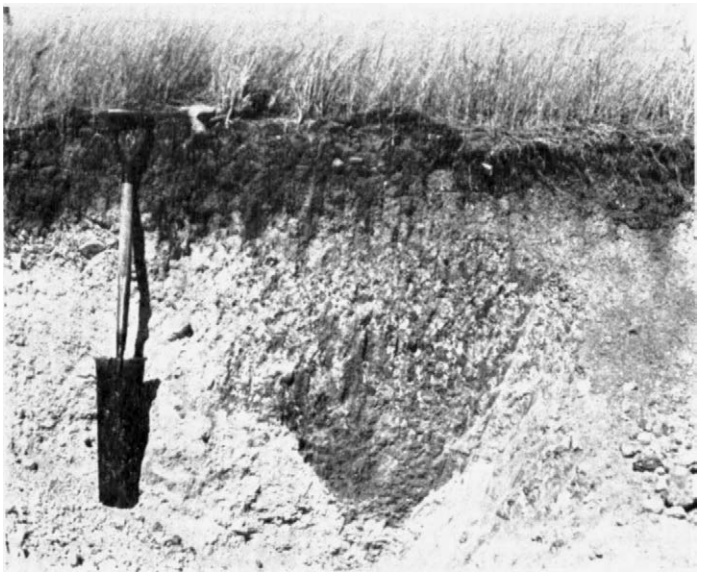

Figure 7.—**Danvers clay loam. The dark-colored surface layer is underlain by a noncalcareous layer that has prismatic or blocky structure and grades to lighter colored, strongly calcareous material.**

Geologists believe that the pebbles underlying these soils were deposited by former streams that flowed from the Little Belt and the Highwood Mountains.

The surface layer ranges from clay loam to gravelly clay loam or cobbly clay loam but is clay loam in most places.

These soils take in water readily, have good moisture-storage capacity, and are well drained. They have a moderate supply of organic matter. Crops respond well to additions of fertilizer.

The Danvers soils occur closely with the Judith soils and are distinguished from them by a noncalcareous, blocky upper subsoil. They have stronger accumulations of lime in the lower subsoil than the Savage soils and are generally less deep to the gravelly substratum.

Danvers clay loam, 0 to 2 percent slopes (Da).—This soil occupies nearly level parts of high benches and terraces. It has a profile like the one described as representative of the Danvers series.

Included on gentle, convex slopes in areas mapped as this soil are areas of Judith clay loam that are less than 1 acre in size and amount to as much as 5 percent of some mapped areas.

This soil is productive and is used extensively for small grain. It is well suited to hay and pasture. The surface layer provides a good seedbed and is easily tilled. Wind erosion is likely in unprotected cultivated areas. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Silty range site, 15 to 19 inches precipitation)

Danvers clay loam, 2 to 4 percent slopes (Db).—This soil occurs on gentle slopes along drainageways and in irregularly shaped areas, some of which have a slope of 0 to 4 percent. It has a profile like the one described as representative of the Danvers series.

Included on convex slopes in areas mapped as this soil are small areas of Judith clay loam and Judith gravelly clay loam that make up less than 10 percent of any mapped area.

This productive soil is cultivated in the same way as are adjacent areas of Danvers clay loam, 0 to 2 percent slopes. Its granular surface layer is susceptible to both wind erosion and water erosion in unprotected areas. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Danvers clay loam, 4 to 8 percent slopes (Dc).—This soil occurs mostly on long, sloping terraces on the north side of Sage Creek, but some areas are on short slopes of higher benches. In some places its noncalcareous subsoil is thinner than the one described in the profile that is representative of the Danvers series. A few pebbles and cobblestones are scattered on the surface of much of this soil.

Included on convex slopes in areas mapped as this soil are areas of Judith clay loam that make up as much as 10 percent of some mapped areas.

This productive soil is suited to small grain, hay, and pasture. Runoff is more rapid than on the more gently sloping Danvers clay loam, and erosion is more likely in unprotected areas where conservation practices are not applied. (Capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Danvers cobbly clay loam, 0 to 4 percent slopes (Dd).—This soil occurs mostly on nearly level or gently sloping benches north of Arrow Creek. It is somewhat similar to the soil described as representative of the Danvers series, but it has pebbles and cobblestones on the surface and more coarse fragments nearer the surface.

Most of this soil is used for small grain, but some is in native range, and some small areas are used for irrigated hay. The moisture-storage capacity of this soil is a little less than that of the Danvers clay loams. The pebbles and cobblestones on the surface help to control wind erosion. Under irrigation, unprotected areas are susceptible to water erosion. (Capability unit IIe–2, dryland, and IIIe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Danvers cobbly clay loam, 4 to 8 percent slopes (Df).—This soil is on short side slopes of drainageways that cross the terraces and are in rolling areas at the edge of benches. Except for the cobblestones on the surface and a larger amount of pebbles and cobblestones in the subsoil, this soil has a profile like the one described as representative of the Danvers series.

Included in areas mapped as this soil are small areas of Winifred cobbly clay loam that make up 10 to 15 percent of some mapped areas.

This soil has lower yields and moisture-storage capacity than Danvers clay loams that are free of cobblestones, but the cobblestones and pebbles provide some protection against wind erosion, though they make tillage difficult. Unprotected areas are susceptible to water erosion. (Capability unit IIIe–2, dryland, and IVe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Danvers cobbly clay loam, 8 to 15 percent slopes (Dg).—This soil occurs on short side slopes of drainageways that cross the benches and on the short slopes between one bench and another. It is shallower than the soil described as representative of the Danvers series, and it contains more coarse fragments throughout.

Some of this soil is in cultivated crops, some is in native pasture, and a small acreage is in irrigated hay. The cobblestones and pebbles reduce the moisture-storage capacity of this soil, and crop yields are less than on the cobble-free, less sloping Danvers soils. Because slopes are moderately steep, water erosion is a problem in unprotected areas. (Capability unit IVe–2, dryland, and IVe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Danvers gravelly clay loam, 0 to 4 percent slopes (Dh).—This soil occurs on high benches in nearly level or gently sloping, fairly small areas. It has more gravel on the surface and in the subsoil than the soil described as representative of the Danvers series. The gravel content of the surface layer and the subsoil ranges from 10 to 25 percent by volume.

This fairly productive soil is cultivated the same way as are adjacent areas of nongravelly Danvers soils. Its moisture-storage capacity is reduced by the gravel content, and it is susceptible to wind erosion. (Capability unit IIe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Danvers stony clay loam, 2 to 4 percent slopes (Dk).—This nearly level and gently sloping soil is on the high benches north of Arrow Creek and east of the Highwood Mountains. It occurs with areas of Danvers cobbly clay loam and contains some cobblestones. The stones in the surface layer and subsoil are 10 to 24 inches across.

This soil is too stony for cultivation but is well suited to range. It produces good yields of forage if range

management is good. (Capability unit VIs–2; Silty range site, 15 to 19 inches precipitation)

Danvers-Judith clay loams, 0 to 2 percent slopes (Dm).—This complex consists of Danvers clay loam and Judith clay loam that are so intermingled that they cannot be shown separately on the soil map. These soils occur on nearly level benches throughout the survey area (fig. 8).

The Danvers clay loam amounts to 50 to 80 percent of this complex, and the Judith clay loam amounts to most of the rest. The Judith soil is on slight rises and is surrounded by Danvers clay loam. Most of the Judith soil, and in some places the Danvers soil, has a blocky subsoil that is thinner than is typical of Judith and Danvers soils.

The soils in this complex are suited to small grain and hay. They are easily tilled, and their surface soil provides a good seedbed. Because of its position and high content of lime, the Judith soil is less productive than the Danvers soil and is more susceptible to wind erosion.

The Central Montana Branch of the Montana Agricultural Experiment Station is located on this complex. (Capability unit IIc–2, dryland; Silty range site, 15 to 19 inches precipitation)

Danvers-Judith clay loams, 2 to 4 percent slopes (Dn).—This complex is in swales, on gently sloping ridges, and in gently sloping, narrow areas along drainageways that cross benches. It consists of Danvers clay loam and Judith clay loam that are so intermingled that they cannot be shown separately on the soil map.

The Danvers soil makes up 40 to 60 percent of this complex, and the Judith soil makes up the rest. Judith clay loam occupies gently sloping ridges and small convex slopes. Danvers clay loam occurs in the swales and on gentle concave slopes. Each soil has a profile similar to the one described as representative of its respective series. In some places gravel is scattered on the surface of the Judith soil.

Figure 8.—**Harvesting winter wheat on Danvers-Judith clay loams, 0 to 2 percent slopes. These soils on benches are widely farmed, mostly to winter wheat.**

The soils in this complex are suited to cultivated crops. Water erosion is more likely in unprotected areas than it is on Danvers-Judith clay loams, 0 to 2 percent slopes, because runoff is more rapid. (Capability unit IIe–1, dryland; Silty range site, 15 to 19 inches precipitation)

Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes (Do).—This complex occurs on terraces that have slopes dominantly less than 3 percent. It consists of Danvers clay loam and Judith clay loam that occur so closely that they cannot be shown separately on the soil map.

The Danvers clay loam amounts to 30 to 70 percent of this complex, and Judith clay loam amounts to the rest. The position of either soil in this complex varies, but the Danvers soil generally is in nearly level areas, and the Judith soil is on gentle slopes. These soils are underlain by shale, generally at a depth of 6 to 8 feet. Except that the underlying gravel bed contains more sand and is more porous, each soil has a profile similar to the one described as representative of its respective series.

The soils in this complex are suitable for dryfarming, and they produce good yields of winter wheat. Unprotected areas are susceptible to wind erosion. Because these soils are shallow to shale, drainage would probably be a problem if the soils were irrigated. (Capability unit IIe–1, dryland; Silty range site, 15 to 19 inches precipitation)

Danvers-Judith gravelly clay loams, 0 to 2 percent slopes (Dp).—This complex consists of Danvers and Judith soils that are so intermingled that they cannot be shown separately on the soil map. It occurs on nearly level or gentle slopes on high benches.

Judith gravelly clay loam makes up 40 to 60 percent of this complex, and Danvers cobbly clay loam makes up the rest. Most of the Judith soil is on slightly convex slopes, but some is on even slopes. The Danvers soil occurs in swales and in nearly level areas. Each soil has a profile similar to the one described as representative of its respective series.

The soils in this complex are productive and are used mostly to produce small grain. A part of the acreage is in pasture. In areas of native grassland, the pebbles and cobblestones are barely noticeable, for they make up only 5 to 15 percent of the surface layer by volume. After years of cultivation, however, the coarse fragments on the surface are more numerous, but they do not damage machines seriously. Wind erosion is likely in unprotected areas. (Danvers part: capability unit IIe-2, dryland; Silty range site, 15 to 19 inches precipitation. Judith part: capability unit IIIs–3, dryland; Silty range site, 15 to 19 inches precipitation)

Darret Series

The Darret series consists of reddish soils that are underlain by bedrock at a depth of about 24 inches. These soils are on rolling uplands in the foothills. They occur closely with the Cheadle soils. A dense cover of native grasses makes up the native vegetation.

In this survey area, Darret clay loam is the most representative and most extensive Darret soil. It has a dark reddish-gray, fine, granular surface layer about 4 inches thick. The upper 10 inches of the subsoil contains more clay than the surface layer and is dark reddish gray to weak red. It has prismatic and blocky structure. The

lower part of the subsoil is weak-red clay loam in which calcium carbonate has accumulated. It merges with clay loam interbedded with shale and sandstone from which the clay loam parent material weathered.

The surface layer is loam, clay loam, or stony clay loam. Depth to bedrock ranges from 18 to 36 inches but is 20 to 30 inches in most places.

These soils absorb water at a moderate to moderately slow rate, are well drained, and have fairly good moisture-storage capacity. Their supply of organic matter is moderate.

The Darret soils are coarser textured throughout than the Terrad soils and are less deep to bedrock than the Fergus soils.

Darret clay loam, 8 to 15 percent slopes (Dr).—This soil occurs in small areas on moderately steep slopes of the rolling uplands. It has a profile like the one described as representative of the Darret series.

Included in areas mapped as this soil are areas of Cheadle channery loam and Darret loam that are as much as 1 acre in size. The acreage of each of these soils makes up 5 to 10 percent of most mapped areas.

Some of this soil is cultivated in the same way as are larger areas of adjacent Fergus soils, and some is in native range. It is best suited to hay, pasture, or range. In unprotected cultivated areas, runoff is rapid and water erosion is a serious hazard. (Capability unit IVe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Darret stony clay loam (4 to 15 percent slopes) (Ds).—This soil occurs on irregular slopes in areas that are adjacent to dikes of igneous rock. Except for its stony surface layer, it has a profile like the one described as representative of the Darret series.

Because it is stony, this soil has been left in native range, which is its best use. Under good range management, yields of forage are good. If stones are removed, this soil could be seeded and used for hay. Erosion is not a problem if the cover of plants is good. (Capability unit VIs–2; Silty range site, 15 to 19 inches precipitation)

Darret-Cheadle complex, 2 to 8 percent slopes (Dt).—This complex consists of Darret clay loam and Cheadle channery loam that are so intermingled that they cannot be shown separately on the soil map. It is on gently rolling uplands.

Darret soils makes up 50 to 80 percent of this complex; Cheadle channery loam, 20 to 50 percent; and Terrad clay, as much as 5 percent of some mapped areas. The Cheadle soil is on small knolls and ridges. It is similar to the soil described for the Cheadle series, but it is deeper to bedrock. The Darret soil is in areas between the knolls and ridges. It has a loam or clay loam surface layer.

Some of the acreage of these soils is cultivated, and some is in tame pasture. Although the Darret soil is well drained and has fair moisture-supplying capacity, the Cheadle soil is droughty. The complex as a whole, however, produces fairly low yields of small grain. Unprotected areas are susceptible to both wind and water erosion. (Darret part: capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation. Cheadle part: capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Darret-Cheadle complex, 8 to 35 percent slopes (Du).—This complex occurs on moderately steep and steep slopes of rolling uplands. It consists of Darret soils and Cheadle soils that are so intermingled that they cannot be shown separately on the soil map.

Cheadle soils make up 20 to 30 percent of areas mapped as this complex, and Darret clay loam makes up 60 to 80 percent of most mapped areas. Big Timber clay loam and outcrops of rock each make up as much as 5 percent of some mapped areas. The Cheadle soils are dominantly stony and occur on ridges and crests, and the Darret soil is on moderately steep and steep slopes below the ridges and crests. In most places the Cheadle and Darret soils have profiles like the ones described as representative of their respective series.

The soils of this complex are well suited to range and produce fair to good yields of forage. Because the Darret soil is moderately steep and steep and the Cheadle soil is stony, this complex is not suitable for cultivation. (Darret part: capability unit VIe–4; Silty range site, 15 to 19 inches precipitation. Cheadle part: Capability unit VIIs–2; Silty range site, 15 to 19 inches precipitation)

Darret-Utica complex (15 to 35 percent slopes) (Dv).—This complex is on steep slopes of gravel-capped benches. It consists of Darret loam and clay loam and Utica gravelly loam that are so intermingled that they cannot be shown separately on the soil map.

The Utica soil is on the crests and steep slopes. It is typical of the Utica series. It accounts for 40 to 60 percent of this complex, and the Darret soils account for the rest. The Darret soils are on slopes below the Utica soil. In some parts of this complex, the Darret soils have a thin layer of alluvium covering the surface, and in many parts they are shallower than typical Darret soils. In other respects, their profile is like the one described as representative of the Darret series.

The soils in this complex are too steep for cultivation. Runoff is rapid, but under good range management these soils produce fair yields of forage. (Capability unit VIe–6; Thin Silty range site)

Dimmick Series

The Dimmick series consists of poorly drained, noncalcareous soils that are clay in most places. These soils occur in slight depressions and in small basins of intermittent lakes. Their native vegetation is water-tolerant grasses and sedges.

The surface layer is generally grayish-brown to dark grayish-brown light clay that has crumb structure and is about 3 inches thick. It is underlain by gray clay that is distinctly mottled with brown and has weak, blocky structure in the upper part and is massive in the lower part. The parent material is clay that developed from fine-textured material brought in from the surrounding uplands.

Although the surface layer is generally clay, it is heavy clay loam in some places. It ranges from 2 to 5 inches in thickness.

These soils have very slow internal drainage. Their thin surface layer contains only a fairly low to moderate supply of organic matter.

Unlike the Fargo and Hegne soils, the Dimmick soils are noncalcareous to a depth of 20 inches or more. The Fargo and Hegne soils are generally calcareous throughout the profile.

Dimmick clay (0 to 1 percent slopes) (Dw).—This soil is in small basins of the uplands and in depressions at the

edge of terraces. It has a profile like the one described as representative of the Dimmick series. Runoff from the surrounding areas directly affects the degree of wetness and the drainage of this soil. During a prolonged wet period, ponded water drowns out plants in some areas, but during dry periods these areas can be revegetated.

Because it is wet and poorly drained, this soil is generally not suitable for cultivation. In most years, it produces good yields of forage. (Capability unit VIw–1; Subirrigated range site)

Duncom Series

The Duncom series consists of dark colored or very dark colored, stony soils that are shallow over limestone. These soils occur on moderate to very steep slopes high in the foothills of the Little Belt Mountains. They are closely associated with the Skagg soils.

Duncom stony loam is the most representative Duncom soil in the survey area. Its very dark brown to very dark grayish-brown surface layer is about 4 inches thick and has weak, granular to weak, blocky structure. It is underlain by grayish-brown, strongly calcareous loam that is about 8 inches thick and has weak, blocky structure. This layer rests on hard limestone that weathered from limestone and shale.

The surface layer is stony loam and stony clay loam. It ranges from 3 to 5 inches in thickness. Depth to bedrock ranges from 8 to 15 inches.

These soils absorb water fairly readily but have low moisture-storage capacity. Their thin surface layer is high in organic-matter content. The Duncom soils are shallower to bedrock than the Skaggs soils. The limestone underlying the Duncom soils distinguishes them from the Cheadle soils and the Spring Creek soils, for the Cheadle soils are underlain by sandstone, and the Spring Creek soils are underlain by igneous rock.

Duncom stony loam (8 to 50 percent slopes) (Dx).—This soil is on moderately steep to very steep slopes in the foothills of the Little Belt Mountains.

Included in pockets and swales in areas mapped as this soil are areas of Skaggs stony loam that amount to 5 to 15 percent of some mapped areas. Ledges of limestone crop out and make up 5 to 15 percent of some mapped areas. Also included are a few areas of Duncom soils that have a surface layer of nonstony clay loam and are underlain by limy shale.

This soil is so stony, steep, and shallow that it cannot be cultivated. Because it is droughty, only low yields of forage can be expected. The most productive native plants can be maintained by good range management. (Capability unit VIIs–2; Shallow range site)

Duncom-Rock outcrop complex (15+ percent slopes) (Dy).—This complex is on steep slopes of mountains and walls of canyons. It consists mostly of Duncom stony loam that is broken by barren ledges of limestone.

The Duncom soil makes up 50 percent or more of this complex, and the ledges of limestone make up 30 to 40 percent. Skaggs stony loam occurs in pockets in some areas, and Raynesford stony loam occurs at the base of some slopes. Together they make up 10 to 15 percent of the complex. The Duncom soil is 6 to 10 inches to bedrock, which is less than average for the Duncom soils.

The soils in this complex are suitable only for range. Because the Duncom soil is very shallow and there is much Rock outcrop, this complex as a whole produces only low yields of forage. The Duncom soil in this complex responds to good range management in the same way as deeper Duncom soils. (Duncom part: capability unit VIIs–2; Very Shallow range site. Rock outcrop part; capability unit VIIIs–1; Very Shallow range site)

Duncom-Skaggs-Rock outcrop complex (15+ percent slopes) (Dz).—This complex occurs in the high foothills and mountainous areas on steep and very steep, broken slopes where limestone and shale crop out in places.

The Duncom soils, Skaggs soils, and outcrops of limestone and shale each make up 20 to 30 percent of this complex. Raynesford stony loam makes up 5 to 15 percent and is at the base of slopes. The Duncom and Skaggs soils are between the outcrops of limestone and shale. They have profiles like the one described for their respective series.

The soils in this complex are too steep, stony, shallow, and broken for cultivation. The complex as a whole produces low yields of forage, but the most productive grasses can be maintained by good range management. (Duncom part: capability unit VIIs–2, dryland; Thin Breaks range site, 20 to 24 inches precipitation. Skaggs part: capability unit VIs–1; Thin Breaks range site, 20 to 24 inches precipitation. Rock outcrop part; capability unit VIIIs–1; Thin Breaks range site, 20 to 24 inches precipitation)

Fargo Series

The Fargo series consists of dark-colored, poorly drained clays that are generally calcareous throughout. These soils occur on nearly level slopes of valley bottoms. They occur closely with the Hegne soils. The native vegetation was dense sedges, rushes, and water-tolerant grasses.

These soils generally have a layer of organic material 1 to 3 inches thick. This layer is underlain by dark gray or very dark gray clay that is 15 to 20 inches thick and has fine granular structure. The thick subsoil is gray and dark gray mottled with yellow, brown, and red in the lower part. It has weak, blocky structure or is massive. The parent material is clay that developed from fine-textured material of the uplands.

At times the water table rises within a few inches of the surface, but generally it fluctuates between depths of 2 and 5 feet. Air and water move through these poorly drained soils very slowly. The supply of organic matter is good.

The Fargo soils are specked and splotched by lime, but they lack the strong accumulations of lime that occur in the associated Hegne soils.

Fargo-Hegne silty clays (0 to 3 percent slopes) (Fa).—This complex consists of Fargo silty clay and Hegne silty clay that are so intermingled that they cannot be shown separately on the soil map. These soils are in the bottom lands along Meadow Creek about 5 miles north of Stanford.

Fargo silty clay amounts to 60 to 80 percent of this complex, and Hegne silty clay amounts to most of the rest. Each of these soils has a profile like the one described as typical of its respective series. The Hegne soil is in the fringe areas and on slight rises, and the Fargo soil is in the general area around the fringes and rises.

This complex of soils is in pasture or wild hay. Most of it is too wet for cultivation. Although drainage is

feasible, tillage is difficult because the content of clay is high. Under cultivation the sand-sized granules are highly susceptible to wind erosion. Because plants receive ample water through subirrigation, pasture yields are good. (Capability unit IVw–1, dryland; Subirrigated range site)

Fergus Series

The Fergus series consists of deep, reddish soils that formed in clay loam material on fans and terraces in the foothills of the survey area.

These soils have a brown to reddish-gray granular surface layer that is free of lime, about 5 inches thick, and easily worked. The surface layer is underlain by reddish-brown or dark reddish-brown heavy clay loam that is about 24 inches thick and has prismatic or blocky structure. It grades abruptly to accumulated white lime. The parent material is reddish clay loam that developed from shale and sandstone.

The subsoil ranges from heavy clay loam to light clay. Depth to lime generally ranges from 20 to 36 inches, but in a few places lime is within 10 inches of the surface, and in a few places it is as much as 40 inches below the surface.

These soils take in water somewhat slowly to readily, have good moisture-storage capacity, and are well drained. Their supply of organic matter is good.

The Fergus soils are more clayey and have a more distinctly prismatic or blocky structure than the Twin Creek soils. The reddish color of the Fergus soils distinguishes them from the grayer Savage soils.

Fergus clay loam, 0 to 2 percent slopes (Fc).—This soil is on nearly level terraces at the outer edges of the lower foothills. It has a profile like the one described as representative of the Fergus series.

Included along streams and in narrow swales in areas mapped as this soil are small areas of Gallatin clay loam that make up 2 to 5 percent of some mapped areas.

Under dryfarming, this soil is well suited to small grain and hay, but under irrigation it is best suited to hay. The granular surface layer provides a good seedbed and is easily tilled. Wind erosion is likely in unprotected clean-cultivated areas. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Clayey range site, 15 to 19 inches precipitation)

Fergus clay loam, 2 to 4 percent slopes (Fd).—This soil occurs on gently sloping fans and on the side slopes of drainageways that cross the nearly level terraces. It has a profile like the one described as representative of the Fergus series.

This soil produces good yields of small grain and hay. The surface layer provides a good seedbed and is easily worked. Unprotected clean-cultivated fields are susceptible to both wind and water erosion. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Clayey range site, 15 to 19 inches precipitation)

Fergus clay loam, 4 to 8 percent slopes (Ff).—This soil is on short sloping fans at the edges of valleys. It has a profile similar to the one described as representative of the Fergus series. The subsoil is less clayey on the upper parts of fans than on the lower part.

This productive soil is suited to hay, small grain, and pasture. Runoff is more rapid than on the more gently sloping Fergus clay loams, and water erosion is more likely in unprotected areas or where conservation practices are not applied. (Capability unit IIIe–2, dryland, and IVe–7, irrigated; Clayey range site, 15 to 19 inches precipitation)

Fergus clay loam, 8 to 15 percent slopes (Fh).—This moderately steep soil occurs on fans and foot slopes of the foothills and is a little higher than the other Fergus soils. It has a profile similar to the one described as representative of the Fergus series.

Included on the lower part of fans in areas mapped as this soil are areas of Fergus clay loam, 4 to 8 percent slopes, that are 1 to 2 acres in size.

Runoff is more rapid on this soil than on the more gently sloping Fergus soils, and water erosion is likely in unprotected cultivated fields. (Capability unit IVe–2, dryland, and IVe–7, irrigated; Clayey range site, 15 to 19 inches precipitation)

Fergus silty clay loam, shale substratum, 2 to 8 percent slopes (Fs).—This soil is on gently rolling uplands. It contains a few pebbles in the uppermost 1 or 2 feet and is underlain by shale at a depth of 2 to 4 feet, but in other respects its profile is like the one described as representative of the Fergus series.

Included on rises and knolls in areas mapped as this soil are small areas of Darret clay loam that make up 10 to 15 percent of some mapped areas.

This productive soil is suited to hay, small grain, and pasture. Because it is shallow to shale, plant roots cannot reach the depth that they do in deeper Fergus soils. Unprotected areas are susceptible to water erosion, and conservation practices are needed to help control erosion in cultivated fields. (Capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Gallatin Series

The Gallatin series consists of deep, dark-colored, imperfectly drained to poorly drained loams and clay loams that are on the bottom lands or low terraces along major streams. The native vegetation is a mixture of mid and tall grasses and, in some places, sedges.

Gallatin clay loam is the most extensive soil of the series. Its granular or crumb surface layer is dark gray to very dark grayish brown and about 18 inches thick. This layer grades to gray or dark-gray, massive clay loam that is mottled with brown and yellow and, in some places, is specked with lime.

The surface layer ranges from 12 to 24 inches in thickness. Worm casts are common in the surface layer and the subsoil. Specks of lime are common in the subsoil. Gravelly and sandy materials are at a depth of 30 to 60 inches. The water table fluctuates between depths of 2 and 4 feet in some places and between 3 and 6 feet in others. Gallatin loam that has a clay substratum occurs in a small acreage.

These soils are moderately permeable, but they are wet because their water table is high or surface runoff is restricted. They are high in organic-matter content. In most places the high water table is beneficial, and where it is too high, generally it can be lowered easily because the sand and gravel in the substratum are fairly loose.

The Gallatin soils have a thicker, darker colored surface layer than the Straw soils and a higher water table. They are calcareous, whereas the Slocum soils are noncalcareous throughout.

Gallatin clay loam (0 to 2 percent slopes) (Ga).—This soil occurs in small areas along some of the major drainageways, mainly in the plains section of the survey area. It has a profile like the one described as representative of the Gallatin series.

Small areas of Lamoure clay loam are included in narrow swales of areas mapped as this soil.

This soil is well suited to hay and pasture. Some of it is used to produce small grain, but in some years the grain lodges and is difficult to harvest. This soil sometimes is so wet that it cannot be worked at the same time as the adjoining well-drained soils, but in dry years it produces higher yields than the well-drained soils. Flooding is a problem at times. (Capability unit IIw–1, dryland; Subirrigated range site)

Gallatin loam (0 to 2 percent slopes) (Gb).—This soil is in narrow areas on bottom lands along some of the major drainageways in the foothills, and, to a lesser extent, in the plains section. Its profile is similar to the one described as representative of the Gallatin series. The water table fluctuates between depths of 2½ and 5 feet.

Small areas of Gallatin clay loam are included in the swales and on the border of areas mapped as this soil.

This soil is used to produce hay and small grain. The smaller, less accessible areas are in native pasture. Yields are good during dry periods when yields are low on the adjoining well-drained soils. During some years overflow is a problem. (Capability unit IIw–1, dryland; Subirrigated range site)

Gallatin loam, clay substratum (0 to 2 percent slopes) (Gc).—This soil occurs only in a few small areas in the valleys of foothills. It is underlain by massive clay at a depth of 20 to 40 inches, but in other respects it has a profile similar to the one described as representative of the Gallatin series. The water table fluctuates between 1 and 3 feet of the surface.

This soil is used for native hay and subirrigated pasture but is too wet for cultivation. Although it could be drained, drainage is not feasible in some places. (Capability unit IIIw–1, dryland; Subirrigated range site)

Gallatin soils, wet (0 to 2 percent slopes) (Gd).—These soils are along perennial streams, where they occur in irregularly shaped bands that are 200 to 500 feet wide. Some areas are entirely Gallatin loam, and some are entirely Gallatin clay loam, but other areas include both soils. These soils are less deep to loose sand and gravel and have a higher water table than the soil described as representative of the Gallatin series. The water table fluctuates between depths of a few inches and 2½ feet.

These soils are too wet for cultivation. Because areas are small and the water table is high throughout the growing season, drainage generally is not practical. These soils are best used for grazing and, under good management, produce good yields of forage. During dry years wild hay can be cut in some places. (Capability unit Vw–1; Wetland range site)

Gallatin and Raynesford loams (0 to 4 percent slopes) (Gr).—These soils are in both the foothills and the plains. They are along meandering streams in areas that are 50 to 350 feet wide.

The proportion of Gallatin loam and Raynesford loam in each mapped area varies from place to place. Typically, the Gallatin soil is in small, nearly level areas along the streambeds, and the Raynesford soil is in the higher areas along the streams and on short fans.

Included in or adjacent to old stream channels in areas mapped as this soil are areas of Lamoure clay loam.

These soils are too irregular in shape and too dissected for cultivation. Also, they are frequently flooded. Most of the acreage is used for grazing. Under proper range management, forage yields are good. Water-tolerant grasses and sedges grow on the Gallatin soil, and mid and tall grasses on the Raynesford soil. Cottonwood trees, willows, grasses, and sedges grow along the Judith River. In some areas native hay is cut from time to time. If these soils are kept in vegetation, they are not likely to erode. (Capability unit VIw–1; Subirrigated range site)

Hegne Series

The Hegne series consists of dark-colored, poorly drained clays. These soils are on nearly level to gently sloping bottom lands of valleys. The native vegetation is water-tolerant grasses and a few sedges.

The granular surface layer of these soils is dark gray to very dark gray and about 7 inches thick. In the subsoil are weak prisms that break to moderate, fine, angular blocks. The subsoil is gray in the upper 1 or 2 feet. The lower part is light-gray, strongly calcareous, massive clay that contains segregations of lime and brown and red mottles. The clay parent material developed in fine-textured material that washed from the uplands.

The surface layer ranges from 6 to 10 inches in thickness. It generally is calcareous, but in some places it is noncalcareous. Immediately below the surface layer, the accumulated lime is faint in some places and prominent in others. At a depth of not more than 20 inches much lime has accumulated.

The movement of air and water is very slow in these soils, but the moisture-storage capacity is good. The supply of organic matter is good.

The layer of lime in Hegne soils is nearer the surface than that in the closely associated Fargo soils.

In this survey area, the Hegne soils are mapped only in a complex with Fargo silty clay.

Hughesville Series

The Hughesville series consists of light-colored, loamy, forested soils that are moderately deep over limestone. These soils occur on steep and moderately steep slopes in the Little Belt Mountains.

These soils are covered by a very thin layer of forest litter that is underlain by gray loam that has crumb structure and is about 1 inch thick. The gray loam is underlain by a brown to dark grayish-brown, blocky layer that is about 12 inches thick, contains more clay than the layer above, and grades to grayish-brown, strongly calcareous sandy clay loam. The parent material is clay loam or sandy clay loam that weathered mostly from limestone and limy shale. Limestone bedrock is at a depth of about 2 feet.

The surface layer generally is loam, clay loam, or stony clay loam. It ranges from ½ inch to 2 inches in thickness. Depth to bedrock ranges from 18 to 30 inches.

These soils take in water readily to somewhat slowly and have fairly good moisture-storage capacity. Hard limestone limits the depth to which roots penetrate. The

organic-matter content is low. Runoff would be very rapid if the cover of vegetation were destroyed.

The Hughesville soils lack the moderately thick, very dark colored surface layer of the Little Horn soils.

Hughesville-Duncom complex (4 to 35 percent slopes) (Hu).—This complex consists of Hughesville and Duncom soils that are so intermingled that they cannot be shown separately on the soil map. It occurs in broad, steeply rolling mountainous areas.

The Hughesville soils make up 65 to 75 percent of this complex; Duncom stony loam, 20 to 30 percent; and rock outcrops and Little Horn soils, about 5 percent. Duncom stony loam occurs on knolls, ridges, and side slopes of drainageways and supports a cover of native grasses and an open stand of trees. Hughesville clay loam and stony clay loam are on thickly wooded side slopes. The Hughesville and Duncom soils have profiles that are similar to the ones described as representative of their respective series. The Little Horn soils are in grassed areas on side slopes, and rock crops out on the points of hills.

This complex is wooded with native trees and is best used as woodland. The trees and the litter from them help to control runoff and erosion, to regulate the flow of streams, and to replenish the supply of ground water. (Hughesville part: capability unit VIe–7; no range site assigned. Duncom part: capability unit VIIs–2; Shallow range site)

Judith Series

The Judith series consists of dark-colored soils that formed in loamy alluvium and are moderately deep to deep over beds consisting of pebbles mixed with material finer than sand. These soils are on high benches and terraces and are nearly level to moderately steep. They developed under a cover of mid grasses.

Judith gravelly clay loams are the most extensive and most representative soils of the series. The crumb surface layer is gray to very dark grayish brown and about 4 inches thick. It grades to a strongly calcareous, grayish-brown or light brownish-gray layer that merges with the very gravelly material at an average depth of 2 feet (fig. 9). Overlying the pebbles is parent material consisting of loamy alluvium and some windblown material. The pebbles underlying these soils were deposited by former streams. Most of these streams flowed from the Little Belt Mountains, but some from the Big Snowy Mountains. The Big Snowy Mountains are outside of the survey area.

The surface layer of Judith soils is calcareous or noncalcareous loam, gravelly loam, stony loam, clay loam, cobbly clay loam, and gravelly clay loam. In many places it is underlain by a transitional layer that is 1 to 3 inches thick and has blocky structure. The depth to the pebbles varies. In some places it is uniformly 24 inches or more, but in other places it ranges from 16 to 20 inches.

These soils take in water readily, are well drained, and have fair to good moisture-storage capacity. The surface layer has a moderate supply of organic matter.

The Judith soils occur closely with the Danvers, Utica, and Ashuelot soils. They lack the noncalcareous, blocky upper subsoil of the Danvers soils and are deeper to the gravelly substratum than the Utica soils.

Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Ja).—This complex consists of Judith and Ashuelot soils

Figure 9.—**Profile of Judith gravelly clay loam. Underlying the dark-colored surface layer is a lighter colored, strongly calcareous layer that merges with very gravelly material at an average depth of 2 feet.**

that are so intermingled that they cannot be shown separately on the soil map. It occurs on nearly level or gentle slopes on high benches southwest of Hobson.

Judith gravelly clay loam makes up 50 to 70 percent of this complex, and Ashuelot gravelly loam makes up the rest. The Ashuelot soil has a profile like the one described as representative of its series. The Judith soil occurs in narrow swales and on gentle convex slopes. It has a profile similar to the one described as representative of the Judith series. In some places it is weakly cemented at a depth of 20 to 30 inches.

The soils in this complex are best suited to pasture, native range, and hay. A part of the acreage has been reclaimed and is used to produce winter wheat. Machines are damaged by pebbles and cobblestones. The Judith soil has fair moisture-storage capacity, but the Ashuelot soil is droughty. For the complex as a whole, yields are low. The soils in this complex are susceptible to wind erosion if they are not protected. (Judith part: capability unit IIIs–3, dryland; Silty range site, 15 to 19 inches precipitation. Ashuelot part: capability unit VIs–3; Shallow range site)

Judith clay loam, 0 to 2 percent slopes (Jb).—This soil is on nearly level parts of benches. The largest area is immediately to the south of Hobson. The underlying pebbles are at a greater depth in this soil than in the soil described as representative of the Judith series.

This soil is well suited to hay and small grain. Some areas are used for irrigated pasture. The surface layer provides a good seedbed and is easily tilled. Wind erosion is likely in unprotected clean-cultivated areas. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith clay loam, 2 to 4 percent slopes (Jc).—This soil occurs on the gentle side slopes of drainageways and in small areas on uneven, nearly level and gentle slopes. Its profile is similar to the one described as representative of the Judith series.

Included on crests of slopes in areas mapped as this soil are areas of Judith gravelly clay loam that make up 5 to 10 percent of some mapped areas. This included soil has only fair moisture-holding capacity.

Although runoff is more rapid and erosion more likely on this soil, most of it is cultivated the same way as are adjacent areas of Judith clay loam, 0 to 2 percent slopes. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith clay loam, 4 to 8 percent slopes (Jd).—This soil occurs on slopes between one bench and another and on the moderate side slopes of drainageways that cross the nearly level benches. The slopes are fairly uniform in some areas, but in other areas they are fairly rolling because they are dissected by small drainageways. This soil has a profile that is similar to the one described as representative of the Judith series.

Included on crests of slopes in areas mapped as this soil are areas of Judith gravelly clay loam that make up 5 to 10 percent of most mapped areas. Also included on the lower concave slopes are areas of Danvers clay loam that amount to 5 to 10 percent of most mapped areas.

This productive soil is suited to hay, small grain, and pasture. Runoff is more rapid than on the more gently sloping Judith clay loams, and water erosion is more likely in unprotected areas. (Capability unit IIIe–2, dryland, and IVe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith clay loam, low terrace (0 to 3 percent slopes) (Jf).—This soil is on the low-lying, young terraces. It has a less compact, coarser textured, gravelly substratum than the soil described as representative of the Judith series. The depth to the gravelly layer is 18 to 30 inches.

This soil occurs in broad areas and is used mainly to produce small grain. A small acreage is in tame pasture, and some of the narrow terraces are in native range. A part of the acreage on the Judith River terraces is in irrigated hay. Because the moisture-storage capacity of this soil is only fair, yields of small grain are less than on the deeper Judith soils that store more moisture. The surface layer provides a good seedbed and is easily worked. Unprotected clean-cultivated areas are susceptible to wind erosion. (Capability unit IIIs–2, dryland, and IIs–1, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith cobbly clay loam, 0 to 4 percent slopes (Jh).—This soil is on gently sloping, high benches that are adjacent to the foothills of the Little Belt Mountains. It is higher than the soil described as representative of the Judith series, and it has more cobblestones and pebbles on the surface and in the subsoil. Coarse fragments amount to 15 to 35 percent of the surface layer by volume.

This soil has lower moisture-storage capacity than the other Judith soils, but because of its higher elevation, it receives 2 to 4 inches more rainfall. Most of this soil is in native range, some is in tame pasture, and a smaller acreage is in small grain. Only fair yields of grain and hay can be expected. The cobblestones and pebbles provide some protection against erosion, though they make tillage somewhat difficult. (Capability unit IIIs–3, dryland, and IIIe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith cobbly clay loam, low terrace, 0 to 4 percent slopes (Jk).—This soil occurs on low terraces in small undulating areas, where it is associated with larger areas of Judith clay loam, low terrace. Compared with the soil described as representative of the Judith series, this soil has more pebbles and cobblestones on the surface and in the subsoil and a coarser, less compacted gravel substratum.

Because this soil is limited in moisture-storage capacity, moderately low yields of small grain can be expected in most years. The cobblestones and pebbles somewhat damage machines, but they help to control wind erosion. This soil is cultivated in the same way as are adjacent areas of Judith clay loam, low terrace. (Capability unit IIIs–3, dryland, and IIIe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith gravelly clay loam, 0 to 2 percent slopes (Jl).—This soil is fairly extensive and occurs on benches in the central part of the survey area. It has a profile like the one described as representative of the Judith series.

Included in swales and low places in areas mapped as this soil are areas of Danvers clay loam and Danvers gravelly clay loam that make up 5 to 10 percent of some mapped areas.

This soil is suited to hay, small grain, and pasture. Part of a bench near Hobson is irrigated and used for hay or pasture. The gravel does not damage machines seriously. Because it is shallow to the gravel bed (16 to 30 inches) and is high in gravel content, this soil has less moisture-storage capacity than have deeper, gravel-free, Judith clay loams. Although the gravel provides some protection, wind erosion is a serious problem in unprotected, clean-cultivated fields. (Capability unit IIIs–3, dryland, and IIs–3, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith gravelly clay loam, 2 to 4 percent slopes (Jm).—This soil occurs in gently undulating areas, on gentle slopes at the edges of broad benches, and on side slopes of drainageways that cross the benches. It has a profile like the one described as representative of the Judith series.

Included in undulating and in irregularly shaped areas mapped as this soil are small areas with slopes of 0 to 2 percent. These inclusions make up 20 to 40 percent of some mapped areas.

Most of this soil is cultivated in the same way as are adjacent areas of Judith gravelly clay loam, 0 to 2 percent slopes. A part of the acreage is in native range, and on a bench near Hobson a small acreage is irrigated hay. Unprotected cultivated fields are susceptible to both wind and water erosion. (Capability unit IIIs-3, dryland, and IIIe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith gravelly clay loam, 4 to 8 percent slopes (Jn).—This soil occurs in small areas on moderate slopes along drainageways that cross the benches and on slopes between

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one bench and another. Generally, the depth to the underlying gravel is less than in the soil described as representative of the Judith series.

Included on the crests of slopes in areas mapped as this soil are areas of Utica gravelly loam that make up 5 to 10 percent of some mapped areas.

Some of this soil is cultivated, and some is in pasture or range. Because this soil is sloping and gravel reduces the moisture-storage capacity, water erosion is a serious problem in the unprotected areas or where conservation practices are not applied. (Capability unit IIIe–4, dryland, and IVe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith gravelly clay loam, low terrace, 0 to 4 percent slopes (Jo).—This soil is in small, nearly level to gently undulating areas on low terraces. It has a less compact and coarser gravel substratum than the soil described as representative of the Judith series and is somewhat lower in moisture-storage capacity.

This soil is generally used and managed in the same way as are adjacent areas of Judith clay loam, low terrace. Because its moisture-storage capacity is limited, moderately low yields of small grain can be expected. (Capability unit IIIs–3, dryland, and IIIe–9, irrigated; Silty range site, 15 to 19 inches precipitation)

Judith-Danvers gravelly clay loams, 0 to 4 percent slopes (Jp).—This complex consists of Judith gravelly clay loam and Danvers gravelly clay loam that are so intermingled that they cannot be shown separately on the soil map. It occurs on side slopes of drainageways and in small gently undulating areas within the larger areas of Danvers-Judith clay loams, 0 to 2 percent slopes.

The Judith soil makes up 40 to 60 percent of this complex, and the Danvers soil makes up the rest. Judith gravelly clay loam occurs on rises, on crests, and on some slopes. It is like the soil described as representative of the Judith series. The Danvers soil is in swales, on concave slopes, and on even slopes. Pebbles and cobblestones amount to 5 to 10 percent, by volume, of the surface layer and the subsoil, which is more than in the soil described as representative of the Danvers series.

Most of this complex is cultivated in the same way as are the broad areas of Danvers-Judith clay loams, 0 to 2 percent slopes, on the adjacent high benches. The soils of this complex are susceptible to wind erosion where conservation practices are not applied. Because of its position, high content of gravel, and shallowness, the Judith soil produces lower yields of small grain than the Danvers soil and is more susceptible to water erosion in unprotected areas. (Judith part: capability unit IIIs–3, dryland; Silty range site, 15 to 19 inches precipitation; Danvers part: capability unit IIe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Judith and Raynesford stony loams, 2 to 8 percent slopes (Jr).—These soils occur on fans and in narrow valleys in the foothills. Some mapped areas include both Judith stony loam and Raynesford stony loam, but some areas are mostly Judith stony loam, and some are mostly Raynesford stony loam. The Judith soil and the Raynesford soil have more stones and cobblestones throughout the profile than the soils described as representative of their respective series. The amount of stones is variable.

Included on the lower part of fans in the areas mapped as these soils are small areas of nonstony Judith and Raynesford soils. Also included are a few small areas that have only a few stones but many cobblestones and pebbles.

Most of the acreage is too stony for cultivation, but some of the small areas that contain cobblestones are used for hay. Under good range management, these soils produce good yields of forage. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Judith and Raynesford stony loams, 8 to 15 percent slopes (Js).—These soils are in the foothills on moderately steep slopes of fans. Except that they contain more stones, each of these soils has a profile like the one described as representative of its respective series.

Because stones make up 10 to 25 percent of these soils, by volume, they are not suitable for cultivation. They are well suited to range and, under good management, produce good yields of forage. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Judith and Savage soils (4 to 8 percent slopes) (Jt).—These soils are on fans in the lower foothills and in the plains of the survey area. Some areas are mostly Judith clay loam or Judith gravelly clay loam, and some areas include both of these soils and Savage clay loam. The Judith soils are on the upper part of fans, and the Savage soils are on the lower part. The Savage clay loam contains more gravel than the soil described as representative of the series.

Some of the acreage, particularly that in the plains, is cultivated, and some is in pasture or native range. The Savage soils are more productive than the Judith soils, although both soils are used and managed in the same way. Because slopes are moderate, water erosion is likely in unprotected areas where conservation practices are not applied. (Capability unit IIIe–2, dryland; Silty range site, 15 to 19 inches precipitation)

Judith-Utica gravelly loams, 4 to 8 percent slopes (Ju).—This complex consists of Judith soils and Utica soils that are so intermingled that they cannot be shown separately on the soil map. It is on the side slopes of drainageways that cross the terraces and in irregularly shaped, moderately sloping areas.

The Judith soil and Utica soil each make up 40 to 60 percent of any mapped area. The Utica soil is generally gravelly loam, and it occupies the ridges, crests, and convex areas. The Judith soil is generally gravelly clay loam, and it occurs on the lower slopes and in swales. Judith clay loam also occurs in some places.

The soils in this complex are cultivated the same way as are the larger, adjacent areas of Judith gravelly clay loam, 2 to 4 percent slopes. For the complex as a whole, yields are moderately low. Because slopes are moderate, runoff is medium to rapid, and water erosion is a serious problem in unprotected cultivated areas. (Judith part: capability unit IIIe–4, dryland; Silty range site, 15 to 19 inches precipitation. Utica part: capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Judith-Utica gravelly loams, 8 to 15 percent slopes (Jv).—This complex occupies edges of moderately steep benches and side slopes of drainageways that cross the benches. It consists of Judith soils and Utica soils that are so intermingled that they cannot be shown separately on the soil map.

Each mapped area of this complex consists of 50 to 80 percent Judith soil and 20 to 50 percent Utica soil. The

Utica soil generally is gravelly loam, and it occurs on the crests of slopes. The Judith soil generally is gravelly clay loam, and it is on slopes below the crests. In some areas, particularly on the lower part of slopes, the Judith soil contains less gravel throughout than is typical of Judith soils.

A part of this complex is cultivated, and a part is in native range. Because the Utica soil is droughty and moderately steep, it is best suited to permanent grass. The Judith gravelly clay loam is fairly productive, but it is susceptible to severe erosion in cultivated areas because it is strongly sloping and has rapid runoff. It is best protected if it is used for hay or pasture. (Judith part: capability unit IVe–5, dryland; Silty range site, 15 to 19 inches precipitation. Utica part: capability unit VIe–6; Silty range site, 15 to 19 inches precipitation)

Lamoure Series

The Lamoure series consists of deep, dark-colored, poorly drained clay loams on nearly level to gently sloping terraces. These soils occur closely with the Colvin soils. The native vegetation consists of water-tolerant grasses and sedges.

These soils are calcareous throughout. The granular surface layer is dark to very dark gray and about 12 inches thick. The gray to light-gray subsoil is strongly calcareous, but segregated lime is not apparent. At a depth of about 3 feet, these soils are underlain by pebbles mixed with material finer than sand. Impermeable shale is at a depth of 6 feet or more.

The surface layer ranges from 10 to 15 inches in thickness. The water table generally fluctuates between depths of 1 and 3 feet. Depth to the gravelly material ranges from 2 to 5 feet.

Except for poor drainage, these soils generally have characteristics favorable for crop production. The supply of organic matter is good.

The Lamoure soils lack the distinct segregations of lime that are in the Colvin soils. In this survey area, Lamoure soils are mapped only with the Colvin soils.

Laurel Series

The Laurel series consists of light-colored, strongly saline clays and clay loams on stream terraces and fans. These soils occur closely with the Arvada soils. They have little or no vegetation.

The surface layer is typically light-gray or light brownish-gray clay loam and is generally less than 1 inch thick. It is underlain by a grayish-brown, blocky layer that is about 2 inches thick and is more clayey than the surface layer. This layer grades to blocky, clayey material that contains many crystals of salts. The parent material is clay loam to light clay alluvium that washed from the uplands.

Depth to the salts ranges from 2 to 6 inches.

The Laurel soils puddle or seal when they are wet. They are moderately well drained and take in water very slowly. Little or no organic matter occurs. The underlying salts are toxic to many plants.

The Laurel soils have thinner layers than the Arvada soils and are less deep to salts.

In this survey area the Laurel soils are mapped only in a complex with Arvada soils.

Lismas Series

The Lismas series consists of moderately light colored clays that are very shallow or shallow over clay shale. These soils are most extensive on breaks along Arrow Creek and Surprise Creek in the north-central part of the survey area. They developed under a sparse cover of mid and short grasses.

The granular surface layer is gray to light olive gray and about 2 inches thick. It is underlain by a gray to pale-olive, blocky layer that contains a variable amount of shale fragments and merges with unweathered shale at a depth of about 10 inches. The parent material is clay that weathered in place from clay shale.

These soils generally are noncalcareous, but in some places they are weakly calcareous. Depth to the unweathered shale ranges from about 8 to 12 inches. Crystals of gypsum are common in the upper part of the shale.

The Lismas soils take in water slowly and lose much of it through runoff. They are low in organic-matter content.

The Lismas soils contain more clay than the Midway soils and are less deep to shale than the Pierre soils.

In this survey area, the Lismas soils are mapped in areas with barren shale and with the Pierre soils.

Lismas-Pierre clays (8 to 35 percent slopes) (la).—This complex consists of Lismas clay and Pierre clay on sharply rolling to hilly areas that generally are dissected by coulees. These soils are so intermingled that they cannot be shown separately on the soil map.

Lismas clay makes up 40 to 60 percent of the complex; Pierre clay, 35 to 50 percent; and outcrops of shale, 5 to 10 percent. Included in swales in some areas mapped as this complex are small areas of Promise clay. The Lismas soil occurs on ridges and steeper slopes, and the Pierre soil is on the lower slopes. The outcrops consist of barren shale on steep crests. In areas of Pierre soil, the depth to shale is less than that in the profile described as representative of the Pierre series.

Because slopes are steep and runoff is rapid, the soils of this complex are not suited to cultivation. They are best suited to range. Because it is shallow, slowly permeable, and low in organic-matter content, the Lismas soil is not favorable for good root growth, and it produces lower yields of forage than the Pierre soil. Trampling of livestock causes considerable damage if this complex is grazed when it is wet and muddy. Under good range management, this complex as a whole produces fair yields of forage. (Lismas part: capability unit VIIs–4; Shallow clay range site. Pierre part: capability unit VIe–3; Shallow clay range site)

Lismas-Shale outcrop complex (15+ percent slopes) (lc).—This complex is on steep and very steep or hilly breaks that are dissected by drainageways. It consists of Lismas clay and outcrops of shale that are so intermingled that they cannot be shown separately on the soil map.

Outcrops of shale make up 40 to 70 percent of this complex; Lismas clay, 30 to 50 percent; and Pierre clay, 5 to 10 percent. The barren shale crops out on the steeper slopes; Lismas clay is in the less steep, more rounded areas, and Pierre clay is in the least sloping areas.

Because of the steep slopes and the outcrops of shale, this complex is suitable only for limited grazing. The Lismas soil produces low yields of forage. Good range management is needed to maintain the most desirable grasses. (Lismas part: capability unit VIIs–4; Shale range site. Shale outcrop part: capability unit VIIIs–1; Shale range site)

Little Horn Series

The Little Horn series consists of very dark colored stony loams that are moderately deep over bedrock. These soils occur on the high plains of rolling uplands in the south-central part of the survey area. They developed under a dense cover of mid and tall grasses.

The crumb surface layer is very dark gray to very dark brown and about 6 inches thick. It is underlain by a brown to dark-brown subsoil of clay loam that is about 12 inches thick and has prismatic or blocky structure. The lower part of the subsoil is strongly calcareous and grades to a light-colored layer having a strong accumulation of lime. This light-colored layer merges with the underlying rock at an average depth of 30 inches. The parent material is clay loam that is partly alluvium and partly material that weathered in place from the underlying limestone, sandstone, and quartz.

In this survey area, the coarse fragments make up 10 to 30 percent of the soil mass, by volume. The surface layer ranges from 5 to 10 inches in thickness. Depth to bedrock ranges from 20 to 40 inches but is mostly 24 to 36 inches.

These soils take in water readily, are well drained, and have good moisture-storage capacity. The organic-matter content is moderately high. Enough coarse fragments occur to interfere with tillage.

The Little Horn soils have a distinct, prismatic or blocky, noncalcareous subsoil that the Skaggs soils lack.

Little Horn stony loam (4 to 15 percent slopes) (Lh).—This soil is high in the foothills on rolling upland plains. It has a profile like the one described as representative of the Little Horn series.

Most of this soil is too stony for cultivation, as was demonstrated where stones were removed from a small area but cultivation was only partly successful. Range is the best use and, under appropriate management, yields of forage are good. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Loberg Series

The Loberg series consists of light-colored, forested soils that developed in moderately fine textured material. These soils occupy rolling areas in the Highwood Mountains and, to a lesser extent, in the Little Belt Mountains. They developed under a fairly dense stand of lodgepole pine and Douglas-fir.

The Loberg soils in this survey area are noncalcareous and are generally stony throughout. Underlying a thin layer of forest litter and humus is a light brownish-gray surface layer about 1 foot thick. The upper part of the surface layer is granular loam, and the lower part is blocky clay loam that is transitional to the subsoil. The pale-brown subsoil contains more clay than the surface layer and has blocky structure. It grades to massive, clayey material. The parent material is heavy clay loam or light clay alluvium that was derived from shale, sandstone, and igneous rock.

Tongues of bleached material from the surface layer extend between blocks in the subsoil to a depth of as much as 24 inches. The subsoil ranges from clay loam to clay. Depth to bedrock is generally more than 40 inches.

These soils absorb water slowly, have good moisture-storage capacity, and are generally well drained. Because the cover of vegetation is good, runoff is slow to medium. In the shade of thick stands of timber, the snow melts slowly at high elevations and helps to replenish the supply of ground water. The organic-matter content is low.

The subsoil of the Loberg soils contains more clay and has a stronger structure than that of the Sapphire soils. Loberg soils lack the very dark-colored surface layer of the Alder and Woodhurst soils, which developed under a cover of grass.

Loberg stony loam (8 to 35 percent slopes) (Lr).—This soil occurs in rolling, mountainous areas. It varies from place to place, but it is somewhat similar to the soil described as representative of the Loberg series. In the Highwood Mountains this soil developed in alluvium that is underlain mostly by shale and sandstone. In the Little Belt Mountains it developed largely from igneous rock.

Included in the Little Belt Mountains in areas mapped as this soil are areas of Cowood stony loam. These inclusions make up less than 15 percent of most mapped areas.

This soil is in native trees and, because of them, is part of a valuable watershed. The trees help protect the watershed. Stones and steep, irregular slopes prohibit cultivation. (Capability unit VIe–7; no range site assigned)

Loberg-Sapphire complex (8 to 35 percent slopes) (Ls).—This complex occurs on moderately steep or steep slopes in the Highwood Mountains. It consists mainly of Loberg soils and Sapphire soils that are so intermingled that they cannot be shown separately on the soil map.

Loberg soils make up 50 to 70 percent of this complex, and Sapphire soils make up 30 to 40 percent. Teton and Woodhurst soils together amount to as much as 10 percent of some mapped areas. The Sapphire soils are generally loam and stony loam and occur mostly in the higher areas. The Loberg soils are on the lower slopes and are generally stony. The Loberg and Sapphire soils each have a profile that is similar to the one described as typical of their respective series. The Teton and Woodhurst soils are in grass.

This complex is too steep and stony for cultivation. The trees help to control runoff and erosion and also to regulate the flow of streams and to replenish the supply of ground water. (Capability unit VIe–7; no range site assigned)

Loamy Alluvial Land (Lo)

This land type is on narrow bottoms that are cut by the meandering channels of intermittent streams. Slopes range from 0 to 4 percent. This land consists of poorly drained to imperfectly drained saline soils that are mainly loam and clay loam. Areas of these soils are commonly broken into small segments by the meandering stream channels.

Because of flooding, wetness, salt content, and stream dissection, these soils are not suitable for cultivation.

Under good range management, plants tolerant of water and salt provide good to fair grazing. (Capability unit VIs–4; Saline Subirrigated range site)

Maginnis Series

The Maginnis series consists of dark-colored, lime-free, loamy soils that are very shallow or shallow over bedrock. These soils occur on gentle to steep uplands and are closely associated with the Absarokee and Alder soils. They developed under a cover of mid and short grasses.

Channery clay loam is the most representative soil of the Maginnis series. Its granular surface soil is dark gray to very dark grayish brown and about 4 inches thick. The subsoil is grayish-brown to olive-gray clay loam that generally has a blocky structure. It grades to hard shale and sandstone at an average depth of 12 inches (fig. 10). The parent material is clay loam that weathered from bedrock and contains many fragments of shale and sandstone.

The surface layer is clay loam, cobbly clay loam, and channery clay loam in the survey area. In many places the subsoil contains slightly more clay than the surface layer. Depth to bedrock ranges from 8 to 18 inches.

These soils are well drained, absorb water somewhat slowly to readily, and have low moisture-storage capacity. They are low in organic-matter content.

The Maginnis soils are less deep to bedrock than the Absarokee soils and have a thinner, less clayey subsoil.

Maginnis cobbly clay loam (15 to 35 percent slopes) (Ma).—This soil occurs on the steep edge of benches in the north and north-central parts of the survey area. Its profile varies from place to place. Generally, the depth to bedrock is more than that in the soil described as representative of the Maginnis series.

Included on the crests of slopes in areas mapped as this soil are areas of Utica gravelly loam that make up 5 to 15 percent of some mapped areas. Shale crops out on the steep knolls and amounts to less than 5 percent of any mapped area.

This soil is too steep for cultivation and is best used as native range. It is droughty because runoff is rapid and moisture-storage capacity is limited. Under good range management, forage yields are fair. (Capability unit VIe–6; Thin Clayey range site)

Maginnis-Absarokee channery clay loams (8 to 35 percent slopes) (Mb).—These moderately steep and steep soils occur in rolling areas that generally adjoin the higher gently rolling uplands. The Maginnis soil is channery clay loam, and the Absarokee soil is clay loam in most places (fig. 11). These soils are so intermingled that they cannot be shown separately on the soil map.

The Maginnis channery clay loam is on crests and knolls and is typical of the Maginnis series. It makes up 60 to 80 percent of most mapped areas, and the Absarokee soils make up most of the rest. Absarokee soils are dominantly of clay loam texture and occur in swales and on the lower slopes. They have a profile that is similar to the one described as representative of the Absarokee series.

The Maginnis soil is too shallow and steep for cultivation. The Absarokee soils have good moisture-storage capacity and are productive. In this complex, however, Absarokee soils are so intermingled with Maginnis channery clay loam that generally they are not accessible for cultivation. This complex as a whole is best suited to range and, under good management, produces fair to good yields of forage. (Maginnis part: capability unit VIe–5; Shallow range site. Absarokee part: capability unit VIe–4; Silty range site, 15 to 19 inches precipitation)

Maginnis-Alder channery clay loams (8 to 35 percent slopes) (Mc).—This complex is on steep, hilly uplands in the foothills of the northwestern part of this survey area. It consists mostly of Maginnis channery clay loam and Alder clay loam that are so intermingled that they cannot be shown separately on the soil map.

The Maginnis soil amounts to 60 to 80 percent of this complex, and the Alder soil amounts to most of the rest.

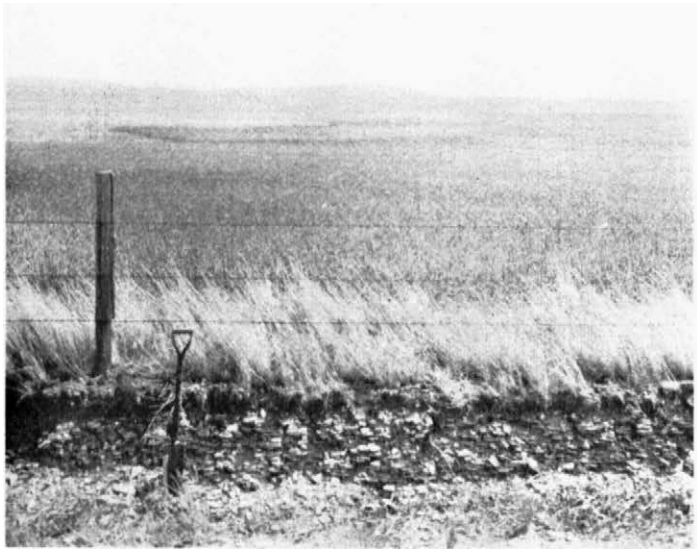

Figure 10.—An area of Absarokee and Maginnis channery clay loams. Maginnis channery clay loam, which is shallow over bedrock, is in the road cut.

Figure 11.—Maginnis-Absarokee channery clay loams. The Maginnis soil is on the crests and knolls, and the Absarokee soil is on lower slopes and concave slopes.

Outcrops and ledges of rock make up 5 to 10 percent of some mapped areas. The Maginnis channery clay loam generally is darker colored than is typical of the Maginnis series. It occurs on knolls, ridges, and crests. The Alder soil generally is clay loam and is on moderately steep and steep slopes below the Maginnis soil.

The Maginnis channery clay loam is droughty and is too steep and shallow for cultivation. The Alder clay loam has good moisture-storage capacity, but generally it is not cultivated, because it is moderately steep and steep and is closely intermingled with the Maginnis soil. This complex as a whole is best used as range and, under good management, produces fair to good yields of forage. (Maginnis part: capability unit VIe–5; Shallow range site. Alder part: capability unit VIe–1; Silty range site, 20 to 24 inches precipitation)

Midway Series

The Midway series consists of light-colored clay loams that are shallow over shale bedrock. In this survey area, these soils occur in small areas in a few places on rolling to hilly uplands in the plains section. They are closely associated with the Chama soils in the rolling areas. Midway soils developed under mid and short grasses. Outcrops of shale are on steep slopes.

These soils are generally calcareous throughout. The grayish-brown to light olive-brown surface layer is about 3 inches thick and has weak, granular structure. The light olive-brown clay loam subsoil contains weathered fragments of shale and sandstone and merges with unweathered bedrock at an average depth of 14 inches. The parent material is clay loam that weathered in place from clay loam shale and sandstone.

The surface layer ranges from 1 to 4 inches in thickness. Depth to the unweathered shale ranges from 8 to 20 inches.

These soils absorb water moderately slowly and have low moisture-storage capacity. They are low in organic matter.

In texture, the Midway soils are intermediate between the Bainville soils and the Lismas soils. Midway soils are finer textured than the Bainville soils, which developed from loam shale and sandstone, and they are coarser textured than the Lismas soils, which developed from clay shale.

Midway clay loam (8 to 35 percent slopes) (Mw).—This soil occurs in small areas on steep, hilly uplands. It commonly adjoins steep areas of Pierre and Winifred soils below gravel benches. Its profile is like the one described as representative of the Midway series.

Included in areas mapped as this soil are areas that have a gravelly clay loam surface layer 2 to 4 inches thick. Shale crops out on steep slopes and makes up 5 to 10 percent of some mapped areas.

This soil is suitable only for limited grazing. Yields of forage are low because runoff is rapid or very rapid and the soil is droughty. Grasses that grow naturally can be maintained by good range management and are the most desirable and most productive. (Capability unit VIe–6; Thin Clayey range site)

Midway-Shale outcrop complex (35+ percent slopes) (Mx).—This steep and very steep complex consists mostly of Midway clay loam and ledges of sandstone and shale. The clay loam is on steep slopes that are broken by the ledges.

The Midway soil makes up 50 to 60 percent of this complex, and the ledges of sandstone and shale make up 20 to 30 percent. Areas of Bainville loam adjoin some of the sandstone ledges, and Straw clay loam occurs at the base of some slopes. Together they make up 15 to 20 percent of the complex. The Midway clay loam is light yellowish brown, but in other respects it is like the soil described as representative of the Midway series.

Because the soils in this complex are steep and shallow, they are suitable only for limited grazing. Even under good range management only low yields of forage can be expected. (Midway part: capability unit VIe–6; Thin Breaks range site, 15 to 19 inches precipitation. Shale outcrop part: capability unit VIIIs–1; Thin Breaks range site, 15 to 19 inches precipitation)

Pierre Series

The Pierre series consists of dark to moderately light colored clays that are underlain by shale at a moderate depth. These soils occupy gentle to moderately steep slopes on rolling uplands of the plains. They are closely associated with Lismas soils.

The granular surface layer is grayish brown to dark grayish brown and is about 3 inches thick. It is underlain by a grayish-brown, blocky subsoil that is about 15 to 24 inches thick and, in many places, has distinct accumulations of lime and gypsum in the lower part. The clay parent material merges with the underlying shale.

Generally, the depth to clay shale ranges from 15 to 30 inches. The lower part of the subsoil and the upper part of the shale contain crystals of gypsum or other salts.

These soils expand when wet and contract when dry. They absorb water very slowly but have good moisture-storage capacity. They have a moderately small supply of organic matter.

The Pierre soils are lighter colored than the Castle soils and are less deep to shale than the Promise soils.

Pierre clay, 2 to 8 percent slopes (Pc).—This soil occurs in only a few small, gently rolling areas. It has a profile like the one described as representative of the Pierre series.

Included in swales in areas mapped as this soil are small areas of Promise clay that make up as much as 5 percent of some mapped areas.

This soil is best used for hay or pasture. Some of the acreage is in native range, and some is cultivated in the same way as are the larger, adjacent areas of Promise clay. Unprotected areas are highly susceptible to both wind and water erosion because permeability is slow and the surface layer has granular structure. This soil is difficult to work and can be tilled only if the moisture content is good. Timely farm operations are needed. Under good management, yields of crops and forage are fair. (Capability unit IVe–7, dryland; Clayey range site, 15 to 19 inches precipitation)

Pierre clay, 8 to 35 percent slopes (Pd).—This soil is in small steep areas adjoining the Winifred and Utica soils. Its depth to shale ranges from 15 to 30 inches, but in other respects it is like the soil described as representative of the Pierre series.

Included on knolls in areas mapped as this soil are small areas of Lismas soils, and included on the lower slopes are

small areas of Promise clay. These inclusions make up as much as 15 percent of some mapped areas.

This soil is too steep for cultivation. It is best suited to range. If cattle graze this clayey soil when it is wet, they compact it and runoff is then increased. Good range management is needed. (Capability unit VIe–3; Clayey range site, 15 to 19 inches precipitation)

Promise Series

The Promise series consists of dark-colored clays that are on terraces, high benches, and rolling uplands. These soils developed under a dense cover of mid grasses.

Promise clays are the most extensive and most representative soils of the series. They have a granular, dark-gray to dark grayish-brown surface layer about 3 inches thick. The blocky subsoil is dark grayish brown to olive gray and about 30 inches thick. In the lower part the subsoil is strongly calcareous and is distinctly splotched with white lime. It grades to less calcareous clay. The parent material is clay that was transported by water or wind or was weathered in place. In some places the clay was locally transported.

In some areas the surface layer is cobbly clay. Promise soils are weakly calcareous at the surface, or they are noncalcareous to a depth of 10 inches or more. The depth to shale is 2½ to 4 feet in the uplands, but it is 5 feet or more on the terraces and high benches.

These soils take in water slowly, are well drained, and have good moisture-storage capacity. They have only a moderate supply of organic matter. When these soils are wet, they expand; when they dry, they contract and crack.

The Promise soils are deeper to shale than the Pierre soils.

Promise clay, 0 to 2 percent slopes (Pm).—This soil occurs on nearly level benches and terraces, where it is relatively pure. Its profile is similar to the one described as representative of the Promise series.

This soil is suited to small grain, hay, and pasture. It is productive but is difficult to work and can be tilled only if the moisture content is good. Because the soil structure is granular in the surface layer, fields that are clean cultivated are susceptible to wind erosion if they are not protected. (Capability unit IIe–3, dryland; Clayey range site, 15 to 19 inches precipitation)

Promise clay, 2 to 8 percent slopes (Po).—This soil occupies rolling areas below and adjoining high benches. Its profile is similar to the one described as representative of the Promise series. In most places depth to shale is 2½ to 4 feet.

This productive soil is used mostly for hay, small grain, and pasture. Some of the more gentle slopes are in irrigated hay. Because of its high content of clay, this soil can be tilled only if the moisture content is good. Because of the slope and slow permeability, water erosion is likely in clean-cultivated fields that are not protected or in other areas where conservation practices are not applied. (Capability unit IIIe–3, dryland, and IVe–8, irrigated; Clayey range site, 15 to 19 inches precipitation)

Promise clay, 8 to 15 percent slopes (Pp).—This soil is in rolling areas and in small areas on side slopes of drainageways. Its profile is similar to the one described as representative of the Promise series.

Included on crests and ridges in areas mapped as this soil are small areas of Pierre clay that make up 5 to 15 percent of some mapped areas.

Most of this strongly sloping soil is farmed in the same way as are adjacent areas of Promise clay, 2 to 8 percent slopes, but runoff is more rapid, and water erosion is much more likely. This soil is best protected if it is in hay or pasture. The more isolated areas are in native range. (Capability unit IVe–4, dryland; Clayey range site, 15 to 19 inches precipitation)

Promise cobbly clay (4 to 15 percent slopes) (Pr).—This soil is on moderate and moderately steep complex slopes in rolling areas. Except that the surface layer is cobbly, it has a profile like the one described as representative of the Promise series. A few stones are scattered on the surface. Small areas in swales have few or no cobblestones.

Most of this soil is in native range. In clean-cultivated areas, the cobblestones provide some protection against erosion, though not enough. The steeper slopes are highly susceptible to water erosion and are best protected where they are used for hay, pasture, or native range. (Capability unit IVe–4, dryland; Clayey range site, 15 to 19 inches precipitation)

Raynesford Series

The Raynesford series consists of deep, very dark colored loams and light clay loams on fans, terraces, and foot slopes, in the foothills of the survey area. These soils occur mostly with Adel soils. They developed under a dense cover of mid and tall grasses.

Raynesford loams are the most extensive and most representative soils of the series. They have a crumb, very dark gray to very dark grayish-brown surface layer that is about 12 inches thick and is easily worked. This layer grades to a gray or light-gray, strongly calcareous subsoil that has weak, blocky structure in the upper part and is massive in the lower part. The parent material is loamy material that washed from the uplands.

The surface layer ranges from 8 to 16 inches in thickness. Some areas are stony.

These soils take in water readily, are well drained, and have good moisture-storage capacity. They have a good supply of organic matter. The strongly calcareous subsoil restricts the growth of roots.

The Raynesford soils have a thinner surface layer than the Adel soils and contain more accumulated lime. In Raynesford soils a light-colored zone of lime is within 16 inches of the surface.

Raynesford and Adel loams, 2 to 4 percent slopes (Ra).—These soils occur on the gently sloping fans and in narrow valleys in the foothills. Some mapped areas are Raynesford loam, and some are Adel loam, but in other areas both soils occur in varying proportions. Each of these soils has a profile like the one described as representative of its respective series.

These soils are well suited to hay, small grain, and pasture. Both soils are productive, but the Adel loam is more so because it has a thicker surface layer and contains more organic matter. Because the growing season is only a little more than 95 days, timely farm operations are needed. Both soils are easily tilled, and their surface soil provides a good seedbed, but uncovered clean-cultivated areas are susceptible to erosion. (Capability unit IIc–1, dryland,

and IIIe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Raynesford and Adel loams, 4 to 8 percent slopes (Rd).—These soils are on sloping fans that are about one-quarter mile long. Some mapped areas are Raynesford loam, and some are Adel loam, but most areas contain both Raynesford loam and Adel loam. These soils occur on convex slopes; the Adel soil is on the more gentle ones, and the Raynesford soil is on the stronger ones. Each soil has a profile like the one described as representative of its respective series.

These soils are highly productive of hay and small grain. Because they have stronger slopes than Raynesford and Adel loams, 2 to 4 percent slopes, runoff is more rapid in unprotected areas where conservation measures are not applied. (Capability unit IIIe–1, dryland, and IVe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Raynesford and Adel loams, 8 to 15 percent slopes (Rf).—These soils occur on moderately steep slopes of small fans or parts of larger fans. In mapped areas the proportion of Raynesford and Adel soils is undetermined, but the Raynesford loam is mostly on the convex slopes, and the Adel loam is on the lower slopes. Each soil has a profile that is similar to the one described as representative of its respective series.

Most of these soils are cultivated in the same way as are areas of the less sloping, adjacent Raynesford and Adel loams. The smaller, less accessible areas are in native vegetation. If well-rooted plants are destroyed in cultivation, runoff is rapid and unprotected cultivated areas are highly susceptible to water erosion. Where feasible, these soils are best used for hay or pasture. (Capability unit IVe–1, dryland, and IVe–6, irrigated; Silty range site, 20 to 24 inches precipitation)

Raynesford and Adel stony loams, 4 to 15 percent slopes (Rn).—These soils are in the foothills of the Little Belt Mountains on short fans and foot slopes. Some mapped areas contain both Raynesford stony loam and Adel stony loam, but others consist entirely of Raynesford stony loam. Stones and cobblestones make up 10 to 20 percent of each area of these soils. In other respects the Raynesford and the Adel soils have profiles like those described as representative of their respective series.

These soils are too stony for cultivation. They are in native range, which is their best use. Under good management, yields of forage are good. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Rhoades Series

The Rhoades series consists of soils that have a moderately thick loam surface layer, a neutral or alkaline clay subsoil, and shale underlying material. These soils are on rolling uplands in the plains of this survey area. They developed under a cover of mid grasses.

Typically, the surface layer is grayish brown and about 6 inches thick. Its structure is mainly blocky, but the lower part is platy. The subsoil is light olive-brown to dark grayish-brown clay about 15 inches thick. It has columnar structure in the upper part and blocky structure in the lower. This layer is underlain by hard shale and sandstone. The parent material is clay or clay loam that weathered from the shale and sandstone.

The surface layer ranges from 4 to 8 inches in thickness and from loam to clay loam in texture. Lime has accumulated in the upper part of the bedrock in some places and just above it in others, but in some areas, instead of lime, the accumulations are gypsum or other salts.

These soils are slowly to very slowly permeable. They have a moderate supply of organic matter.

The Rhoades soils are less deep to shale than the Beckton soils, in which depth to shale is more than 5 feet.

Rhoades-Arvada complex (2 to 8 percent slopes) (Ro).—This complex is on gently rolling uplands. It consists of Rhoades soils and Arvada soils that are so intermingled that they cannot be shown separately on the soil map.

Rhoades loam makes up 40 to 50 percent of this complex, and Arvada clay loam, 40 to 50 percent. In addition, bare spots of Laurel clay loam make up 5 to 10 percent of most mapped areas, and Pierre and Promise soils, 10 to 15 percent of a few. The Rhoades soil ranges from 4 to 8 inches in thickness. In some places lime has accumulated in the lower part of the subsoil or the upper part of the bedrock, but in other places this soil is noncalcareous and contains accumulated salts. The Arvada soil occurs in slight depressions that are sparsely covered with vegetation. It is moderately deep over shale, but in other respects it has a profile like the soil described as representative of the Arvada series. The Pierre and Promise soils are on rises in areas less than 2 acres in size.

The soils of this complex are best used for hay, or native range. The Rhoades soil supports a good stand of grasses and produces fair yields of small grain and hay, but because the Arvada clay loam has a thin surface layer and is low in organic-matter content, it produces only low yields. For the complex as a whole, yields are low. (Capability unit IVs–1, dryland; Panspots range site)

Saline Land (Sa)

This land type occurs on seepy foot slopes, in seepy upland swales, and in narrow valleys along upland drainageways in the plains part of the survey area (*13*). Slopes range from 2 to 15 percent. The ground water moves laterally on the shale underlying this land and seeps out at the edge of benches and in swales. Seepage is slow but steady much of the time. Salts are brought to the surface and accumulate there in varying amounts. The soil materials are mainly clay loam and clay.

This land type is suitable only for grazing. It generally supports a good growth of plants tolerant of salt and water, but in a few places where large amounts of salt have accumulated at the surface, the vegetation is sparse. Spots of this land type that occur in cultivated fields should be left in permanent vegetation or seeded to it. (Capability unit VIs–4; Saline Subirrigated range site)

Sapphire Series

The Sapphire series consists of light-colored, loamy, forested soils that are moderately deep over standstone. These soils are on moderate to steep slopes of the Highwood Mountains and the Little Belt Mountains.

Sapphire loams are the most representative soils of the series. They have a thin layer of forest litter overlying a light brownish-gray surface layer that is about 8 inches thick and is platy in the upper part and blocky in the

lower. The subsoil contains more clay than the surface layer and is light brownish gray, has blocky structure, and is about 18 inches thick. The subsoil rests on shattered sandstone, from which the loam parent material has weathered.

These soils have a stony loam surface layer in a small acreage of the survey area. Depth to sandstone generally ranges from 18 to 30 inches. In some places these soils are reddish colored because they developed partly from dark-red or reddish-brown sandstone. The underlying sandstone is generally gray.

These soils take in water readily and are well drained. The moisture-storage capacity is limited by the underlying sandstone and its coarseness. Much moisture filters into the sandstone and helps to replenish the supply of ground water. The organic-matter content is low.

The Sapphire soils developed from coarser textured material than the Loberg soils and contain less clay in the subsoil.

Sapphire soils (4 to 35 percent slopes) (Sb).—This mapping unit is in wooded, mountainous areas on moderate to steep slopes that generally face north. It is made up of Sapphire loam and Sapphire stony loam. Sapphire loam has a profile similar to the one described as representative of the Sapphire series.

Included on ridges in areas mapped as this soil are small areas of Cheadle stony loam and Cheadle channery loam that make up less than 5 percent of most mapped areas.

These soils are still in native trees, mostly lodgepole and ponderosa pines that are harvested for posts and poles. Although the cover of trees and of litter is good and runoff is generally slow or medium, runoff is rapid and erosion is a serious problem if the protective cover is removed. The cover on these soils encourages moisture to filter into the underlying bedrock and thus adds to the underground water supply and helps regulate the flow of streams. (Capability unit VIe–7; no range site assigned)

Sapphire-Cheadle complex (8 to 35 percent slopes) (Sc).—This complex is in hilly areas on moderately steep or steep slopes that generally face north. It consists of Sapphire soils and Cheadle soils that are so intermingled that they cannot be shown separately on the soil map.

Cheadle channery loam and Cheadle stony loam make up 30 to 40 percent of the complex; Sapphire loam, 50 to 65 percent; and Skaggs loam, 5 to 10 percent of some mapped areas. In this complex the Cheadle soils are on knolls and ridges in grassed areas that have open stands of trees. They formed mainly in reddish material, but in other respects they are similar to the soil described as representative of the Cheadle series. The Sapphire soil is on side slopes that surround the knolls and ridges. It has a profile that is similar to the one described as representative of the Sapphire series. The Skaggs soil is transitional between the Cheadle soils and the Sapphire soil.

Because the Cheadle soils are shallow and droughty, yields of forage are lower than those on the Sapphire soil. The cover of trees on the Sapphire soil encourages moisture to filter into the underlying sandstone and helps to regulate the flow of streams and to replenish the supply of ground water. Runoff would be rapid and erosion severe if the protective cover were removed. (Sapphire part: capability unit VIe–7; no range site assigned. Cheadle part: capability unit VIIs–2; Shallow range site)

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Savage Series

The Savage series consists of deep, dark-colored soils that formed in clay loam and light clay material on fans and stream terraces in the plains of the survey area.

Savage silty clay loams are the most extensive and most representative soils of the series. Under native grass, they have a granular, grayish-brown to very dark grayish-brown surface layer that is free of lime and is about 4 inches thick. In cultivated fields the surface layer is the plow layer and is 6 inches thick. The subsoil is grayish brown to dark grayish brown, is about 1 foot thick, and has prismatic or blocky structure. It grades to a light brownish-gray, blocky layer that contains accumulations of white lime and less clay than the subsoil. The underlying parent material is calcareous, alluvial clay loam that is easily penetrated by roots.

The surface layer is silty clay in some places. Depth to lime ranges from 10 to 24 inches. In some areas the lower part of the subsoil is 10 to 20 percent gravel.

These soils are well drained. They take in water slowly to moderately slowly, and have good moisture-storage capacity. Their supply of organic matter is good.

The grayish-brown color of the Savage soils distinguishes them from the reddish-colored Fergus soils. The Savage soils contain more clay in their subsoil than the Straw soils and more lime in the lower part of their subsoil.

Savage silty clay, 0 to 2 percent slopes (Sd).—This nearly level soil is at the outer edge of some terraces. Its surface layer and subsoil contain more clay than that of the soil described as representative of the Savage series.

Included on gently sloping fans in areas mapped as this soil are small areas of Savage silty clay loam that make up 5 to 10 percent of some mapped areas.

This soil is difficult to work because its content of clay is high. A favorable moisture content is needed if a good seedbed is to be prepared or other tillage performed. Under good management, including timely farm operations, yields of hay and small grain are good. Some of the acreage in hay is irrigated. The granular silty clay of a prepared seedbed is highly susceptible to wind erosion if left uncovered. Conservation practices are needed. (Capability unit IIe–3, dryland, and IIs–2, irrigated; Clayey range site, 15 to 19 inches precipitation)

Savage silty clay, 2 to 4 percent slopes (Se).—This soil is on gently sloping fans at the outer edges of areas of Savage silty clay, 0 to 2 percent slopes. Its surface layer and subsoil contain more clay than those of the soil described as representative of the Savage series.

This soil produces good yields of hay, small grain, and pasture under good management. Because the content of clay is high, a favorable content of moisture is needed if a good seedbed is to be prepared or other tillage performed. The granular surface layer of prepared seedbeds is highly susceptible to wind erosion where it is not protected by a plant cover or where conservation practices are not applied. Because this soil is gently sloping and slowly permeable, it is subject to water erosion, particularly in irrigated fields. (Capability unit IIe–3, dryland, and IIIe–8, irrigated; Clayey range site, 15 to 19 inches precipitation)

Savage silty clay, 4 to 8 percent slopes (Sf).—This soil occurs only in a few small areas on fans and foot slopes.

Its surface layer and subsoil are more clayey than those in the profile described as representative of the series.

Most of this soil is cultivated in the same way as are the adjacent, more gently sloping Savage silty clays, but water erosion is more likely, especially in irrigated areas. (Capability unit IIIe–3, dryland, and IVe–8, irrigated; Clayey range site, 15 to 19 inches precipitation)

Savage silty clay loam, 0 to 2 percent slopes (Sg).—This soil occurs on nearly level terraces that are nearly one-quarter mile wide. Its profile is like the one described as representative of the Savage series.

Included on the outer edges of terraces in some areas mapped as this soil are small areas of Savage silty clay.

This soil is well suited to small grain and hay. It is fairly easy to work, and the surface layer provides a good seedbed. Wind erosion is likely, however, in unprotected clean-cultivated areas. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Clayey range site, 15 to 19 inches precipitation)

Savage silty clay loam, 2 to 4 percent slopes (Sh).—This soil occurs on gentle side slopes of drainageways that cross terraces and on gently sloping fans that adjoin the nearly level terraces. In a few places it contains gravel throughout.

Included on fans in some areas mapped as this soil are small areas of Straw clay loam.

This soil is cultivated in the same way as are adjacent areas of Savage silty clay loam, 0 to 2 percent slopes, but the slope is stronger, runoff is more rapid, and water erosion is more likely in unprotected areas. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Clayey range site, 15 to 19 inches precipitation)

Savage silty clay loam, 4 to 8 percent slopes (Sk).—This soil is on the fans and foot slopes below the Winifred, Absarokee, and Maginnis soils on uplands. It generally adjoins the nearly level terraces on which other Savage soils occur. It has a profile that is similar to the one described as representative of the Savage series.

Included on foot slopes in some areas mapped as this soil are small areas of Winifred clay loam.

This soil produces good yields of hay, small grain, and pasture. Runoff is more rapid than on the more gently sloping Savage silty clay loams, and water erosion is more likely in unprotected areas where conservation practices are not applied. (Capability unit IIIe–2, dryland, and IVe–7, irrigated; Clayey range site, 15 to 19 inches precipitation)

Skaggs Series

The Skaggs series consists of soils that have a very dark colored surface layer and a light-colored, strongly calcareous subsoil. These soils are moderately deep over bedrock. They are high in the foothills of the Little Belt Mountains on gentle to steep upland slopes. They developed under a dense cover of mid and tall grasses.

Skaggs clay loams are the most representative soils of this series in the survey area. Their surface layer is dark brown to very dark brown when dry, is about 7 inches thick, and is easily worked. Under native vegetation, this layer has crumb structure in the upper 2 or 3 inches and weak blocky in the lower part. In cultivated fields the plow layer has weak, crumb structure. The subsoil is gray to light brownish gray, is strongly calcareous, and has weak, blocky structure. It is about 15 inches thick and is underlain by bedrock of limestone, limy shale, or sandstone. The loamy parent material consists partly of residuum that weathered in place from the bedrock and partly of alluvium that was deposited on the bedrock.

The surface layer of these soils is loam, clay loam, and stony clay loam. It ranges from about 3 to 8 inches in thickness. Depth to bedrock generally ranges from 18 to 36 inches, but it is as much as 4 feet in some areas where the soil formed in alluvium.

These soils absorb water readily, are well drained, and have fair to good moisture-storage capacity. Their supply of organic matter is good in areas having a thicker than normal surface layer but is somewhat low where the surface layer is thinner.

The Skaggs soils lack the noncalcareous, blocky subsoil of the Little Horn soils. They are deeper to bedrock than the shallow or very shallow Duncom soils.

Skaggs loam (4 to 15 percent slopes) (Sl).—This soil is on rolling uplands in the foothills of the Little Belt Mountains. It formed in loam that weathered from soft sandstone and generally is reddish throughout. The thickness of the surface layer ranges from 5 inches on the convex slopes to as much as 8 inches on the lower slopes. In cultivated areas on the convex slopes, the surface layer is lighter colored than in other areas because the limy subsoil has been mixed with it. The slope generally ranges from 4 to 15 percent, but in some places it is 4 to 8 percent.

Included on ridges and knolls are small areas of Cheadle channery loam that make up 5 to 15 percent of some mapped areas.

This soil is best used for hay, tame pasture, or native range. On the convex slopes, yields of small grain are low because the soil is shallow and has only fair moisture-storage capacity. Because runoff is rapid, this soil is highly susceptible to water erosion where cultivation destroys the firmly anchored living plants. (Capability unit IVe–5, dryland; Silty range site, 20 to 24 inches precipitation)

Skaggs clay loam, 4 to 8 percent slopes (Sm).—This soil occurs on the rolling uplands and on tilted plateaus in the foothills. It is generally deeper than the soil described as representative of the Skaggs series because most of it formed in 2 to 4 feet of alluvium overlying bedrock. In places a few cobblestones are on the surface.

This soil produces good yields of hay, small grain, and pasture. It has good moisture-storage capacity. It is easily tilled, and its surface soil provides a good seedbed, but in unprotected clean-cultivated areas, both wind and water erosion are likely. Conservation practices are needed to lessen runoff and control erosion. Because the growing season is fairly short, timely farm operations are needed. (Capability unit IIIe–1, dryland; Silty range site, 20 to 24 inches precipitation)

Skaggs clay loam, 8 to 15 percent slopes (Sn).—This soil occurs on moderately steep slopes of rolling uplands and on side slopes of drainageways that extend into the less sloping uplands. Generally, it has thinner layers than the soil described as representative of the Skaggs series, but in other respects it is similar to that soil. In some cultivated areas the light-colored, strongly calcareous subsoil is mixed with the surface soil.

Included on crests of slopes in areas mapped as this soil are small areas of Duncom soils.

This soil is best suited to hay, tame pasture, or native range. Where the vegetative cover is destroyed by cultivation, runoff is rapid and the unprotected areas are highly susceptible to water erosion. (Capability unit IVe–5, dryland; Silty range site, 20 to 24 inches precipitation)

Skaggs stony clay loam (4 to 15 percent slopes) (So).—This soil occurs on moderate to moderately steep slopes of tilted uplands. Except for its stony surface layer, it has a profile like the one described as representative of the Skaggs series.

Included on ridges in areas mapped as this soil are areas of Duncom stony loam. Also included, in pockets and swales, are areas of Skaggs clay loam. Each of these inclusions make up 5 to 15 percent of many mapped areas.

This soil is too stony for cultivation and is used for range. It produces good yields of forage under good management. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Skaggs-Cheadle complex (8 to 35 percent slopes) (Sp).—This complex is in a few moderately steep and steep, hilly areas in the foothills of the Little Belt Mountains. It consists of areas of Skaggs soils and of Cheadle soils that are so intermingled that it is impractical to show them separately on the soil map.

Cheadle channery loam and Cheadle stony loam make up 25 to 50 percent of this complex, and Skaggs loam makes up 50 to 75 percent of most areas. Rock crops out in small areas on ridges. The Cheadle soils are on knolls and ridges. They formed in reddish material, but in other respects they are similar to the soil described for the Cheadle series. The Skaggs soils are on slopes below the knolls and ridges and in areas that surround them. Except for a loam surface layer that is underlain by sandstone, their profile is like the one described as representative of the Skaggs series.

Because this complex is shallow, stony, and moderately steep or steep, it is not suitable for cultivation. It is used for range. Only low yields of forage can be expected on the Cheadle soils because they are droughty. Yields are higher on the Skaggs soils. The most desirable grasses can be maintained by good range management. (Skaggs part: capability unit VIe–1; Silty range site, 20 to 24 inches precipitation. Cheadle part: capability unit VIIs–2; Shallow range site)

Skaggs-Duncom stony clay loams (8 to 35 percent slopes) (Sr).—This complex is high in the foothills on moderately steep and steep upland plains. It consists of Skaggs soils and Duncom soils that are so intermingled that they cannot be shown separately on the soil map.

Skaggs clay loam and stony clay loam make up 40 to 60 percent of this complex, and Duncom stony loam makes up the rest. Ledges of rock crop out in small areas. The Duncom soils are on ridges and crests and in areas that are generally tilted. They have a profile like the one described for the Duncom series. The Skaggs soils occupy the less sloping areas.

This complex as a whole is too stony for cultivation. It is suitable only for range. The very shallow and shallow Duncom soils are droughty and produce lower yields of forage than the Skaggs soils. The most desirable grasses can be maintained by good range management. (Skaggs part: capability unit VIs–1; Silty range site, 20 to 24 inches precipitation. Duncom part: capability unit VIIs–2; Shallow range site)

Skaggs-Raynesford loams, 8 to 35 percent slopes (Ss).—These soils occur on fairly long, mountainous slopes where the landscape is unevenly rolling and varies as the underlying material varies from hard to soft. The soils are so intermingled that they cannot be shown separately on the soil map.

Skaggs loam and stony loam make up 40 to 60 percent of this complex, and Raynesford loam, 20 to 40 percent. Teton loam and Castle clay together amount to as much as 15 percent of some mapped areas. In many places there are small outcrops of limestone, sandstone, and igneous rock. Skaggs loam and stony loam are underlain by limestone and shale. Raynesford loam is in coves and on small foot slopes and small fans. The Skaggs soils and the Raynesford soil each have a profile that is similar to the one described as representative of its respective series.

The soils in this complex are too steep and stony for cultivation. They are well suited to range. The most desirable and most productive grasses can be maintained by good range management. (Capability unit VIe–1; Silty range site, 20 to 24 inches precipitation)

Skaggs-Duncom-Hughesville complex (4 to 35 percent slopes) (St).—This complex is in areas that are transitional between grassland and woodland. It is high in the foothills of the Little Belt Mountains on moderate to steep, uneven slopes. It consists of Skaggs, Duncom, and Hughesville soils that are so intermingled that they cannot be shown separately on the soil map.

Skaggs soils and Hughesville soils each make up 30 to 40 percent of this complex, and Duncom stony loam makes up 20 to 30 percent. The Skaggs soils are generally clay loam and stony clay loam. They occur on moderate to moderately steep slopes in parklike areas and in areas that support open stands of trees. The Hughesville soils are generally stony and in places intergrade to the Skaggs soil. They occur in areas that support dense stands of ponderosa pine, lodgepole pine, and Douglas-fir. The Skaggs soils and the Hughesville soils each have a profile that is similar to the one described as representative of its respective series. The Duncom stony loam occurs on the sides of sharp coulees and in some of the less sloping, open areas. It has a profile like the one described as representative of Duncom series.

Because the soils in this complex are stony, shallow, and moderately steep to steep, the complex as a whole is not suitable for cultivation. The Duncom soil is droughty and produces lower yields of forage than the Skaggs soils. The most desirable grasses can be maintained by good range management. Some trees are harvested for posts, poles, and building logs, but it is best to leave the protective cover of trees on these soils. This cover helps to control runoff and to regulate the flow of streams. (Skaggs part: capability unit VIe–1; Silty range site, 20 to 24 inches precipitation. Duncom part: capability unit VIIs–2; Shallow range site. Hughesville part: capability unit VIe–7; no range site assigned)

Slocum Series

The Slocum series consists of deep, dark-colored, imperfectly drained soils that formed in noncalcareous, loamy material. These soils are on fans and in narrow valleys in the foothills. The vegetation is mainly quaking aspen and grasses.

The surface layer is dark-gray to dark grayish-brown loam that has crumb structure and is about 16 inches thick. It is underlain by light brownish-gray clay loam that has blocky structure to a depth of about 30 inches and is massive below. The parent material was derived from igneous rock of the uplands and is stratified alluvium of loam and clay loam texture.

The surface layer ranges from about 12 to 18 inches in thickness. In places pebbles are scattered throughout the profile. The water table fluctuates between depths of 3 and 5 feet.

These soils take in water readily and have good moisture-storage capacity, but poor drainage restricts the kinds of plants that grow. The supply of organic matter is good.

Unlike the calcareous Gallatin soils, the Slocum soils are noncalcareous throughout.

Slocum loam (2 to 6 percent slopes) (Su).—This soil is in narrow valleys in the foothills of the Highwood Mountains on short, gently sloping or moderately sloping fans and on gently sloping low terraces. It has a profile like the one described as representative of the Slocum series.

This soil is suited to hay and pasture if it is cleared of trees. It occurs in such small, narrow areas that producing grain is hardly practical. (Capability unit IIw–1, dryland; Subirrigated range site)

Spring Creek Series

The Spring Creek series consists of dark-colored soils that are very shallow or shallow over igneous rock. In this survey area, these soils occur closely with Woodhurst soils on moderate to steep slopes in the foothills and with Blaine soils in the plains. They developed under a cover of mid and short grasses.

Spring Creek stony loam is the most representative soil of the series. It has a crumb, grayish-brown to dark grayish-brown surface layer that is noncalcareous and about 6 inches thick. This layer grades to grayish-brown or light-gray, strongly calcareous material that merges with the bedrock at an average depth of 12 inches. The parent material is loam that weathered in place from igneous and metamorphic rocks.

The surface layer is loam or stony loam that ranges from 3 to 10 inches in thickness. Depth to bedrock ranges from 6 to 20 inches.

These soils readily take in water, some of which filters through cracks and crevices in the bedrock. Because the soils are shallow, their moisture-storage capacity is low. Their supply of organic matter is low to moderate.

The Spring Creek soils are shallower to bedrock than Blaine soils and lack their blocky, noncalcareous subsoil. The parent material of Spring Creek soils weathered from igneous rock, but Cheadle soils formed in material weathered from sandstone, and Duncom soils formed in material weathered from limestone.

Spring Creek-Blaine stony loams (8 to 35 percent slopes) (Sv).—This complex occupies hilly uplands immediately east of the Highwood Mountains, and it is in a few small areas in the central part of the survey area. The Spring Creek and the Blaine soils occur so closely together that mapping them separately is impractical.

Spring Creek soils and Blaine soils each make up 40 to 60 percent of any mapped area. Parts of igneous dikes crop out in places and amount to 5 percent of some mapped areas. The Spring Creek soil is stony loam that is mainly on sharp rises, knolls, and crests. It has a profile typical of the Spring Creek series. Most of the Blaine soil is a stony loam. It occurs on side slopes and in general areas between ridges and knolls. Its profile characteristics are like those in a typical Blaine soil.

This complex is too steep and strong for cultivation, but it is well suited as range. The Spring Creek soil is droughty and produces much less forage than the deeper Blaine soil. If range management is good, runoff is held to a minimum and the most desirable and most productive grasses can be maintained. (Spring Creek part: capability unit VIIs–2; Shallow range site. Blaine part: capability unit VIs–2; Silty range site, 15 to 19 inches precipitation)

Straw Series

The Straw series consists of deep, dark-colored soils that formed in loam and clay loam material. These soils are on fans and stream terraces in the plains of the survey area. They developed under a dense cover of mid grasses.

The surface layer is dark grayish-brown clay loam of crumb structure that is about 7 inches thick and is easily worked. It is underlain by a weak, blocky subsoil that is about 6 inches thick and is generally a little lighter colored than the surface layer. The subsoil grades to grayish-brown calcareous material that contains faint to distinct segregations of white lime. The parent material is calcareous loam or light clay loam alluvium that washed from the uplands and is easily penetrated by roots.

The surface layer ranges from 5 to 10 inches in thickness and is weakly calcareous or noncalcareous. Depth to fairly loose gravel and sand is generally more than 3 feet.

These soils take in water readily, are well drained, and have good moisture-storage capacity. They have a moderate supply of organic matter.

The Straw soils lack the reddish color of the Twin Creek soils and contain less clay in their subsoil than the Savage soils.

Straw clay loam, 0 to 2 percent slopes (Sw).—This soil occurs on nearly level terraces that are 300 feet to ¼ mile wide. Its profile is like the one described as representative of the Straw series. In places a few pebbles and cobblestones are scattered on the surface and throughout the profile.

This productive soil is used mainly for small grain and hay. Some of the acreage in hay is irrigated. Tillage is easy, and the fine-textured, crumb-structured plow layer provides a good seedbed, but unprotected areas that are clean cultivated are susceptible to wind erosion. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Silty range site, 15 to 19 inches precipitation)

Straw clay loam, 2 to 4 percent slopes (Sx).—This gently sloping soil occurs on fans and in small, uneven areas along drainageways that cross nearly level terraces. Its profile is similar to the one described as representative of the Straw series.

Included on the uneven gentle slopes in areas mapped as this soil are areas of Straw clay loam, gravelly substratum. These inclusions make up less than 15 percent of any mapped area.

This soil is well suited to hay, small grain, and pasture. In its more nearly level areas, it is similar to Straw clay loam, 0 to 2 percent slopes, and can be used in about the same way, but it is susceptible to both water and wind erosion where it is clean cultivated. Also, it is more difficult to irrigate and to manage. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Straw clay loam, gravelly substratum (0 to 4 percent slopes) (Sy).—This soil occurs on terraces that range from a few hundred feet to about one-quarter mile in width. The largest area occupies slopes of less than 2 percent, but some uneven, gently sloping areas are in drainageways. Except for the gravelly substratum at a depth of 20 to 36 inches, the profile of this soil is like the one described as representative of the Straw series. The depth to gravel generally is less than 3 feet, but in some of the more nearly level areas it is slightly more than 3 feet. A little gravel is on the surface in some places, particularly in the unevenly sloping areas.

Because this soil has a gravelly substratum, its moisture-storage capacity is limited. Only fair yields of small grain and hay can be expected under dryland farming, but higher yields are obtained under irrigation. The surface layer is easily tilled and provides a good seedbed. If this soil is left uncovered, clean-cultivated areas are susceptible to wind erosion and gently sloping areas are exposed to water erosion. (Capability unit IIIs–2, dryland, and IIs–1, irrigated; Silty range site, 15 to 19 inches precipitation)

Terrad Series

The Terrad series consists of dark-reddish clays and silty clays on rolling uplands and on terraces in the lower foothills. These soils developed under a dense cover of mid grasses.

Terrad clays are the most extensive and most representative soils of the series. They have a granular, dark-brown to reddish-gray surface layer about 4 inches thick. The upper part of the subsoil contains more clay than the surface layer and is dark reddish gray to weak red, noncalcareous, and about 1 foot thick. It has distinct, blocky structure. The lower part of the subsoil is calcareous and contains small segregations of white lime. It merges with red clay beds at an average depth of 40 inches. The parent material consists of clay that weathered in place from shale, or from alluvium that derived from shale.

In this survey area the surface layer is clay or silty clay. The depth to clay shale ranges from 24 to 50 inches on the uplands, but it is more than 5 feet on the terraces.

These soils take in water moderately slowly. They are well drained on the uplands but are only moderately well drained on the terraces. The moisture-storage capacity is good, and the supply of organic matter is moderate.

The Terrad soils contain more clay throughout than do the Fergus and Darret soils. Their reddish color and distinct, blocky subsoil distinguish Terrad soils from the grayer Promise soils, which have a prismatic subsoil.

Terrad clay, 2 to 8 percent slopes (Ta).—This soil is on gentle and moderate slopes of the rolling uplands. Its profile is like the one described as representative of the Terrad series.

Included in areas mapped as this soil are areas less than 1 acre in size on short slopes of 8 to 12 percent. Generally, these inclusions make up less than 5 percent of each mapped area.

This productive soil is suited to hay, small grain, and pasture. Because of its high clay content, it is difficult to work. A favorable content of moisture is needed if tillage is to be successful and a good seedbed prepared. The granular surface layer is highly susceptible to wind erosion where left uncovered. Because this soil is moderately slow in permeability and has medium to rapid runoff, it is highly susceptible to water erosion if conservation practices are not applied. (Capability unit IIIe–3, dryland; Clayey range site, 15 to 19 inches precipitation)

Terrad clay, 8 to 35 percent slopes (Tb).—This soil occupies moderately steep slopes of drainageways and rolling uplands. It occurs closely with Terrad clay, 2 to 8 percent slopes. Depth to shale generally is less than that in typical Terrad soils.

Included in some areas mapped as this soil are small areas of Darret clay loam.

Where feasible, this soil is best suited to hay, pasture, or native range. Most of it is cultivated in the same way as are adjacent areas of Terrad clay, 2 to 8 percent slopes. Because runoff is rapid in cultivated fields, there is high susceptibility to water erosion if the fields are not protected. (Capability unit IVe–4, dryland; Clayey range site, 15 to 19 inches precipitation)

Terrad silty clay, 0 to 2 percent slopes (Tc).—This soil occurs on some of the narrow, nearly level terraces in areas where the plains merge with the lower foothills of the Little Belt Mountains. It is deeper than the soil described as representative of the Terrad series, for it extends to a depth of more than 5 feet. In some places the water table is at a depth of 4 to 6 feet, but in most places it is deeper.

This soil is used for hay and small grain. In areas where the water table is high, tillage is delayed in spring and alfalfa does not grow well or live long. Drainage is needed in some cultivated areas. The granular surface layer is highly susceptible to wind erosion in clean-cultivated areas. (Capability unit IIe–3, dryland, and IIs–2, irrigated; Clayey range site, 15 to 19 inches precipitation)

Teton Series

The Teton series consists of very dark colored loamy soils that are moderately deep over sandstone. These soils are on gentle to steep slopes in the foothills and mountainous areas of the uplands. They developed under a dense cover of mid and tall grasses.

Teton loam is the most representative soil of this series in the survey area. It has a very dark grayish-brown to black surface layer that is about 9 inches thick and is easily worked. Generally, this layer has fine crumb structure in the upper part and fine blocky structure in the lower part. The subsoil contains more clay than the surface layer and is lighter colored. It is brown or grayish brown, is about 30 inches thick, and has blocky structure. The parent material is loam or light clay loam that weathered in place from the underlying sandstone.

These soils have a stony loam or channery loam surface layer in a small acreage of the survey area. Generally, they are noncalcareous throughout, but in places there are

faint to distinct accumulations of white lime at a depth of more than 30 inches. The depth to bedrock ranges from 24 to 50 inches, but in some places where the sandstone is broken, water penetrates much deeper.

These soils take in water readily, are well drained, and have good moisture-storage capacity. They have a good supply of organic matter.

The Teton soils are deeper to bedrock than the closely associated, shallow Cheadle soils. They are less deep to bedrock than the Adel soils, which are more than 5 feet deep. Their subsoil contains less clay than that of the Alder soils.

Teton loam, 2 to 8 percent slopes (Td).—This gently sloping to moderately sloping soil occurs on rolling uplands. It has a profile like the one described as representative of the Teton series. A few fragments of sandstone are on the surface and throughout the soil.

Included on knolls in areas mapped as this soil are areas of Cheadle loam and channery loam that make up less than 10 percent of any mapped area.

This highly productive soil is used mainly for small grain and hay. It is easily tilled, and its surface layer provides an excellent seedbed. Because rainfall is relatively high and the growing season is short, timely farm operations are needed. Clean-cultivated areas are susceptible to both wind and water erosion if they are left uncovered and conservation practices are not applied. (Capability unit IIIe–1, dryland; Silty range site, 20 to 24 inches precipitation)

Teton loam, 8 to 15 percent slopes (Tf).—This soil occupies only a few moderately steep areas, high in the rolling uplands. Its profile is like the one described as representative of the Teton series.

Included in areas mapped as this soil are small areas of Cheadle channery loam and of Adel loam. Each soil makes up 5 to 10 percent of some mapped areas. The Cheadle soil is on crests, and the Adel soil is on short fans.

This soil is best suited to hay or pasture. Where the protective vegetation has been destroyed by cultivation, runoff is rapid and the unprotected areas are highly susceptible to water erosion. (Capability unit IVe–1, dryland; Silty range site, 20 to 24 inches precipitation)

Teton-Adel stony loams (8 to 35 percent slopes) (Th).—These soils are high in the foothills on uneven slopes where the landscape varies as the underlying material varies from hard to soft. The soils are so intermingled that they cannot be shown separately on the soil map.

Adel stony loam makes up 30 to 40 percent of areas mapped as this complex; Teton stony loam, 50 to 60 percent of most mapped areas; and Cheadle stony loam, 10 to 15 percent of most mapped areas. Teton stony loam is on the convex slopes. Except for its stony surface layer, it has a profile similar to the one described as representative of the Teton series. The Adel soil is in sags, in swales, and on small fans. Its subsoil contains more lime than that of the soil described for the Adel series. Cheadle stony loam is on crests and ridges.

This complex of soils is too steep and stony for cultivation, but it is suitable for range. The Teton and Adel soils each have good moisture-storage capacity and allow roots to penetrate deeply. The most desirable and productive grasses can be maintained by good range management. (Capability unit VIs–1; Silty range site, 20 to 24 inches precipitation)

Teton-Cheadle channery loams, 4 to 15 percent slopes (Tk).—This moderate and moderately steep complex is in the rolling uplands. It consists of Teton soils and Cheadle channery loam that are so intermingled that they cannot be shown separately on the soil map.

Cheadle channery loam makes up 25 to 40 percent of this complex, and Teton soils make up the rest. The Cheadle soil occurs on knolls, ridges, and convex slopes. It is deeper to sandstone than the soil described for the Cheadle series. The Teton soils are loam and channery loam. They occur between ridges and on side slopes that surround knolls, generally on slopes of less than 8 percent. The Teton loam has a profile similar to the one described as representative of the Teton series.

The Teton soils are productive of hay, small grain, and pasture. They are easily tilled, but wind and water erosion are likely if the surface is left uncovered or where conservation practices are not applied. The Cheadle soil is droughty and produces much lower yields than the Teton soils. Seeding to permanent pasture is best on the Cheadle soil where that use is feasible. (Teton part: capability unit IIIe–1, dryland; Silty range site, 20 to 24 inches precipitation. Cheadle part: capability unit VIe–5; Silty range site, 20 to 24 inches precipitation)

Teton-Cheadle stony loams, 4 to 15 percent slopes (Tm).—This complex is in the foothills on uneven slopes of tilted plains. It consists of Teton loam and stony loam and of Cheadle stony loam that are so intermingled that they cannot be shown separately on the soil map.

Teton loam and stony loam make up 60 to 80 percent of areas mapped as this complex, and Cheadle stony loam makes up the rest. The Cheadle stony loam occurs on ridges and in some of the less sloping areas. Its profile is like the one described as representative of the Cheadle series. The Teton soils are mostly between the ridges. Except that it is stony, Teton stony loam has a profile similar to the one described as representative of the Teton series.

Most of this complex is too stony for cultivation. Cultivation is impractical in areas consisting of Teton soils, because the Teton loam is in small areas or is closely intermingled with the Teton stony loam. The Cheadle soil is stony and droughty. The complex as a whole produces good yields of forage under good range management. (Teton part: capability unit VIs–1; Silty range site, 20 to 24 inches precipitation. Cheadle part: capability unit VIIs–2; Silty range site, 20 to 24 inches precipitation)

Teton-Cheadle stony loams, 15 to 35 percent slopes (Tn).—This complex occurs in the foothills of the Little Belt Mountains on steep, uneven slopes. It consists mainly of Teton stony loam and Cheadle stony loam that are so closely intermingled that they cannot be shown separately on the soil map.

The Teton stony loam and Cheadle stony loam each make up 40 to 50 percent of this complex. Adel stony loam makes up 5 to 15 percent of most mapped areas, and outcrops of sandstone amount to 5 percent of some mapped areas. The Cheadle soil is on crests and ridges and is shallower to bedrock than the soil described as representative of the Cheadle series. The Teton soil is in areas below the crests and ridges, generally on slopes of less than 25 percent. Its profile is similar to the one described

for the Teton series. Adel stony loam is in coves on slopes and on fans at the base of slopes.

The soils in this complex are too steep and stony for cultivation, but they are suitable for range. The Cheadle soil is droughty and produces much lower yields of forage than the Teton soil. On this complex good range management encourages the most desirable and most productive grasses. (Teton part: capability unit VIs–1; Silty range site, 20 to 24 inches precipitation. Cheadle part: capability unit VIIs–2; Shallow range site)

Twin Creek Series

The Twin Creek series consists of deep, reddish loams and clay loams. These soils are on fans and stream terraces in the foothills of the survey area.

Twin Creek loam is the most extensive and most representative Twin Creek soil in the survey area. It has a dark-brown to dark reddish-brown surface layer that is about 8 inches thick, is free of lime, and is easily worked. Generally, this layer has granular or weak, platy structure in the plow layer and weak, medium, blocky structure below. The subsoil is about 15 inches thick and has a more distinctly reddish hue than the surface layer. It has weak and moderate, prismatic or blocky structure. The subsoil is underlain by a layer containing faint or distinct segregations of white lime. The parent material is loamy, calcareous alluvium and is easily penetrated by roots.

These soils are mostly free of sandstone fragments, but on some of the steeper slopes coarse fragments amount to as much as 20 percent of the lower subsoil.

These soils take in water readily, are well drained, and have good moisture-storage capacity. Their supply of organic matter is moderate.

The Twin Creek soils have less clay in their subsoil than the Fergus soils. The reddish color of the Twin Creek soils distinguishes them from the Straw soils, which are more yellow.

Twin Creek loam, 2 to 4 percent slopes (To).—This soil occurs on the gently sloping fans at the outer edges of valleys and, to a lesser extent, on narrow terraces of streams. Its profile is like the one described as representative of the Twin Creek series.

Included on the upper part of most fans in areas mapped as this soil are areas of Twin Creek loam that have a 5 or 6 percent slope. These inclusions are less than 2 acres in size.

This soil produces good yields of small grain and hay. It is easily tilled, and the surface layer provides a good seedbed. Where left without plant cover, clean-cultivated areas are susceptible to wind erosion and, to a lesser extent, to water erosion. (Capability unit IIe–1, dryland, and IIIe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Twin Creek loam, 4 to 8 percent slopes (Tp).—This soil is on short, sloping fans at the outer edges of valleys. Throughout the profile, in some places, there are traces of sandstone fragments and a few stones, but in other respects this soil is typical of the Twin Creek series.

This productive soil is suited to hay, small grain, and pasture. Because of the slope, runoff is more rapid than on Twin Creek loam, 2 to 4 percent slopes, and erosion is more likely in unprotected areas or where conservation practices are not applied. (Capability unit IIIe–2, dryland, and IVe–7, irrigated; Silty range site, 15 to 19 inches precipitation)

Twin Creek loam, 8 to 15 percent slopes (Tr).—This moderately steep soil is on foot slopes and short fans. It contains more fragments of sandstone throughout than the soil described as representative of the Twin Creek series, and in some places it is less deep to bedrock. Bedrock is at a depth of 30 inches on some of the higher and steeper slopes.

This soil is best suited to hay or pasture. Where the firmly anchored living plants have been destroyed by cultivation, runoff is rapid and the unprotected areas are highly susceptible to water erosion. (Capability unit IVe–5, dryland; Silty range site, 15 to 19 inches precipitation)

Twin Creek clay loam, 0 to 2 percent slopes (Tw).—This soil is on nearly level terraces that are 200 feet to one-quarter mile wide. Because it contains more clay throughout than Twin Creek loam, its moisture-holding capacity is slightly higher.

Included on ridges and short fans in areas mapped as this soil are areas of gravelly soils that have slopes of 2 to 4 percent. These inclusions are as much as 2 acres in size, and they make up less than 15 percent of any mapped area.

Dryfarmed areas of this soil are well suited to winter wheat and hay, but irrigated areas are best suited to hay. The fine, granular plow layer provides a good seedbed and is easily tilled, but where left uncovered, the clean-cultivated areas are susceptible to wind erosion. (Capability unit IIc–2, dryland, and IIc–3, irrigated; Silty range site, 15 to 19 inches precipitation)

Utica Series

The Utica series consists of dark-colored soils that occur on high benches, have a thin surface layer, and are very gravelly and loamy (fig. 12). These soils developed under a cover of mid grasses.

Utica gravelly loam is the most representative Utica soil in the survey area. Its granular surface layer is dark gray to very dark grayish brown and is about 5 inches thick. This layer is directly underlain by light-colored, strongly calcareous parent material consisting of pebbles mixed with material finer than sand. The parent material was deposited by former streams that flowed from the Little Belt Mountains.

The surface layer is gravelly loam, cobbly loam, and stony loam. It ranges from 3 to 6 inches in thickness. The coarse fragments amount to 60 to 80 percent of the material underlying the surface layer. The finer material is commonly stratified loamy sand to sandy clay loam.

These soils take in water readily, are excessively drained, and have low moisture-storage capacity. Their organic-matter content is low to moderately low.

The Utica soils have more pebbles and cobblestones within 10 inches of the surface than the closely associated Judith soils.

Utica gravelly loam, 2 to 8 percent slopes (Ua).—This gently sloping soil occurs on ridges, on sides of drainageways, and in narrow bands at the outer edge of benches. Its profile is like the one described as representative of the Utica series.

Included in swales in areas mapped as this soil are small areas of Judith gravelly clay loam.

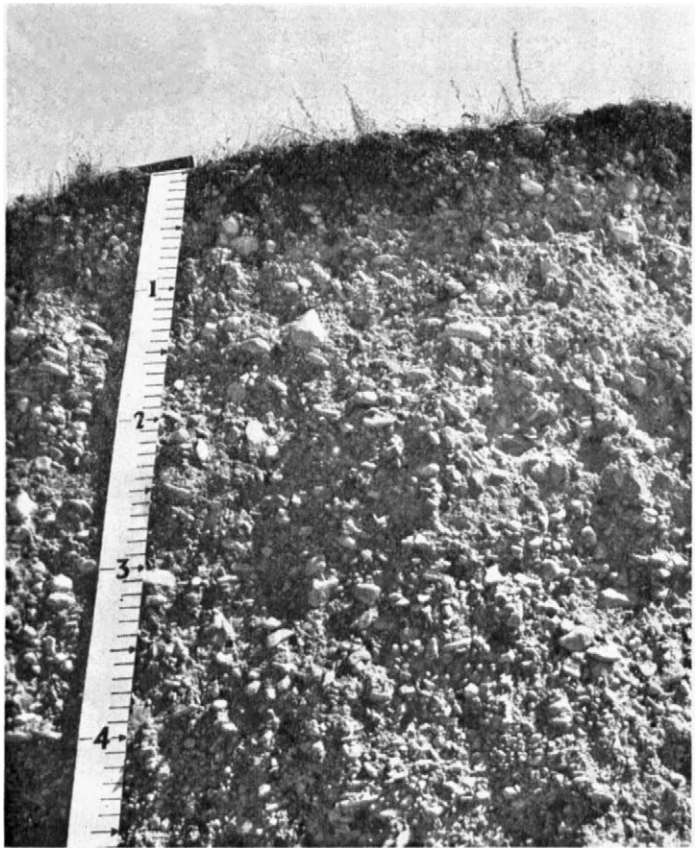

Figure 12.—**Profile of Utica gravelly loam, 8 to 35 percent slopes.**

This soil occurs in small areas, and much of it is cultivated in the same way as are adjacent areas of Judith and Danvers soils. Some areas are in native range. Because this soil has a high content of gravel and is droughty, it produces only low yields of small grain and hay. It is best used for hay, pasture, or native range where these uses are feasible. Forage yields are fair if range management is good. (Capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Utica gravelly loam, 8 to 35 percent slopes (Ub).—This soil occurs on moderately steep and steep slopes at the edge of benches and on side slopes of drainageways that cross the benches. Its profile is similar to that described as representative of the series except that the surface layer is thinner.

Included on the lower slopes in areas mapped as this soil are areas of Judith gravelly clay loam that make up 10 to 15 percent of some mapped areas.

This soil is best suited to range. It is too steep, dissected, and uneven for cultivation. Much water is lost through runoff, particularly during heavy rainfall and where the snow melts rapidly or blows away. Forage yields are fairly low. The most desirable grasses can be maintained by good range management. (Capability unit VIe–6; Thin Silty range site)

Utica-Judith gravelly loams, sandy substratum (0 to 4 percent slopes) (Ug).—This complex occurs on undulating terraces along some of the large streams in the survey area. It consists of Utica gravelly loam and Judith soils that are so intermingled that they cannot be shown separately on the soil map.

The Utica gravelly loam and the Judith soils each make up 40 to 60 percent of any area mapped as this complex. The Utica soil is on the higher lying convex slopes. It contains less accumulated lime than the soil described as representative of the Utica series and is underlain by coarser and more porous material. The Judith soils are loam and gravelly loam. They occur in swales in the low-lying areas between convex slopes. They contain less accumulated lime than the soil described as representative of the Judith series and are underlain by coarser material.

This complex is best suited to pasture or hay. The Utica part of the complex is droughty and produces low yields of small grain and hay. Higher yields can be expected from the Judith part, but the complex as a whole produces low yields. (Capability unit IVe–6, dryland; Silty range site, 15 to 19 inches precipitation)

Utica-Judith stony loams (2 to 8 percent slopes) (Uh).—This complex consists of Utica stony loam and Judith soils that are so intermingled that they cannot be shown separately on the soil map. In this survey area, it occurs only in a few narrow, dissected areas along drainageways.

The Utica stony loam amounts to 40 to 60 percent of each area mapped as this complex, and the Judith soils account for the rest. The Utica soil occurs on the edges of old stream channels and on small, low ridges within areas consisting mostly of Judith soils. The Judith soils are stony loam and cobbly loam, and they occur in the more gently sloping areas. The Utica stony loam and the Judith stony loam each have a profile that is similar to the one described as representative of its respective series, except that the surface layer is stony instead of gravelly.

The soils in this complex are too dissected and too stony for cultivation and are best suited to range. Under good range management, the complex as a whole produces fair yields of forage. The Judith soils can be expected to produce higher yields than the Utica soil. (Capability unit VIs–2; Silty range site, 15 to 19 inches precipitation)

Wet Land (Wa)

This land type is in seepy areas where slopes range from 2 to 8 percent. It consists of poorly drained areas of clay loam and clay in swales of the uplands and on slopes below and adjoining gravelly benches and terraces. Because of the position of this land, it is continually fed by water that filters down through the materials in the benches and terraces and then moves laterally on the underlying shale until it seeps out at the edges. The degree of wetness is highly variable. Depth to shale ranges from 20 inches to more than 5 feet.

This land type is too wet for cultivation. It produces a good growth of water-tolerant grasses and sedges. Plants that grow naturally are the most productive and can be maintained by good range management. (Capability unit VIw–1; Subirrigated range site)

Winifred Series

The Winifred series consists of dark-colored soils that formed in clayey material on rolling uplands in the plains section of the survey area. These soils are moderately deep

or deep over shale. They developed under a dense cover of mid grasses.

The surface layer is dark grayish-brown to gray clay loam that has granular structure and is about 3 inches thick. The subsoil is heavy clay loam or light clay, is about 33 inches thick, and has prismatic or blocky structure. The lower part of the subsoil is splotched with white lime. The parent material is clay loam or clay alluvium that is mixed with locally transported weathered shale.

In this survey area the surface layer is clay loam and cobbly clay loam. In some places both the upper and the lower parts of the subsoil are splotched by white lime. Depth to shale ranges from 30 to 50 inches.

These soils take in water moderately slowly, are well drained, and have good moisture-storage capacity. They have a good supply of organic matter.

The Winifred soils contain less clay than the Promise and Pierre soils and have a thicker, more distinct subsoil.

Winifred clay loam, 0 to 4 percent slopes (Wb).—This soil occurs on benches and low terraces in small, very gently rolling areas, where it is generally associated with sloping areas of Winifred clay loam. Its profile is similar to the one described as representative of the Winifred series. Pebbles and cobblestones are strewn over the surface in some places.

Included in some swales in areas mapped as this soil are areas of Savage soils. Most of this soil is cultivated. Where clean-cultivated areas are left uncovered, the granular surface layer is susceptible to wind erosion and, to a lesser extent, to water erosion. (Capability unit IIe–1, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred clay loam, 4 to 8 percent slopes (Wc).—This soil is in rolling areas. It is the most representative and most extensive soil of the Winifred series in the survey area (fig. 13). A few pebbles and fewer cobblestones are scattered on the surface and in the profile.

Included on small fans in areas mapped as this soil are areas of Savage clay loam that make up less than 15 percent of any mapped area. Also included on remnants of some benches are small areas of Judith and Danvers soils.

This soil is one of the most productive in the survey area. Most of it is cultivated. Its surface layer provides a good seedbed and is fairly easy to till. Because runoff is rapid, this soil is highly susceptible to water erosion where conservation practices are not applied. Unprotected clean-cultivated areas are susceptible to wind erosion. (Capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred clay loam, 8 to 15 percent slopes (Wd).—The larger areas of this soil occur in landscape that is generally strongly sloping, but some small areas are along the sides of coulees. This soil has thinner layers and is shallower to shale than is typical of the Winifred soils.

Included on crests of slopes in areas mapped as this soil are areas of Pierre clay that make up 5 to 10 percent of some mapped areas.

Some of this soil is cultivated in the same way as are adjacent areas of Winifred clay loam, 4 to 8 percent slopes, and some is in native range. Where the vegetation has been destroyed by cultivation, runoff is rapid and the unprotected areas are highly susceptible to water erosion. Consequently, this soil is best used for hay, pasture, or native range where one of those uses is feasible. (Capability unit IVe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Figure 13.—**Winifred clay loam, 4 to 8 percent slopes, is underlain by shale at an average depth of 3 feet.**

Winifred cobbly clay loam, 2 to 8 percent slopes (Wf).—This soil occurs in rolling areas, where it is closely associated with Winifred clay loams. It is somewhat similar to the soil described as representative of the Winifred series, but it has pebbles and cobblestones on the surface and is a little deeper to shale.

This productive soil is cultivated in the same way as are areas of adjacent Winifred clay loams. Except for mowing and raking hay and for combining short barley, the cobblestones only slightly hinder the use of machines. Wind and water erosion are likely in unprotected cultivated areas or where conservation practices are not applied, though the cobblestones provide some protection. (Capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred cobbly clay loam, 8 to 15 percent slopes (Wh).—This soil is in strongly sloping and rolling areas, generally below the edge of steep benches. Cobblestones amount to 10 to 20 percent of the soil material, by volume, and in some places a few stones are on the surface. In other respects this soil has a profile similar to the one described as representative of the Winifred series.

This soil is best suited to pasture, hay, or native range. Where the vegetation has been destroyed by cultivation, runoff is rapid and water erosion is likely. The cobblestones and stones are numerous enough and large enough to make tillage somewhat difficult. (Capability unit IVe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred-Judith clay loams (4 to 15 percent slopes) (Wk).—This complex is on slopes at the edge of benches and in uneven, rolling areas having remnants of small benches. It consists mainly of Winifred soils and Judith soils that are so intermingled that they cannot be shown separately on the soil map.

Winifred clay loam makes up 60 to 80 percent of this complex; Judith soils, 20 to 40 percent of most mapped areas; and Utica gravelly loam, 5 to 10 percent of some mapped areas. The Judith soils are clay loam and gravelly clay loam. They occur on the upper slopes at the edge of benches and on the remnants of benches. Judith soils are underlain by shale at a depth of 4 to 6 feet. Except for this depth to shale, the Judith gravelly clay loam has a profile similar to the one described as representative of the Judith series. The Winifred soil is on the lower slopes, and the Utica soils are on the crests of slopes. The Winifred soil is similar to the soil described as representative of its series.

The Winifred soil is more productive than the Judith soils because it is less sloping and can store more water. But it is not practical to cultivate only the less strong slopes, and the complex as a whole is best suited to hay, pasture, or range. Unprotected cultivated areas are highly susceptible to wind and water erosion. (Capability unit IVe–2, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred-Rhoades clay loams (2 to 8 percent slopes) (Wm).—This complex is on foot slopes 300 to 500 feet long. It consists mainly of Winifred clay and Rhoades clay loam that are so intermingled that they cannot be shown separately on the soil map.

Winifred clay makes up 50 to 60 percent of each mapped area of this complex; Rhoades clay loam, 30 to 50 percent of most mapped areas; and Laurel clay loam, 5 to 10 percent of some mapped areas. The Winifred soil occurs on the convex slopes. Except that its surface layer is clay instead of clay loam, it has a profile that is similar to the one described as representative of the Winifred series. The Rhoades clay loam is mostly in swales and other lowlying areas. It has a clay loam instead of a loam surface layer, and it contains gypsum in the lower part of the subsoil, but in other respects its profile is similar to the one described as representative of the Rhoades series. The Laurel soil occurs in small spots and is closely associated with Rhoades clay loam.

This complex as a whole can produce only fair yields of small grain and hay. The Rhoades soil is less productive than the Winifred soil because it is more slowly permeable and contains less organic matter. The Laurel clay loam produces very little. The granular surface layer of these soils is susceptible to wind erosion where the clean-cultivated fields are left bare. Because runoff is rapid on the moderately sloping soils, water erosion is also a problem. (Winifred part: capability unit IIIe–2, dryland; Clayey range site, 15 to 19 inches precipitation. Rhoades part: capability unit IIIs–1, dryland; Clayey range site, 15 to 19 inches precipitation)

Winifred-Utica clay loams (15 to 35 percent slopes) (Wn).—This complex is at the edge of steep benches that extend into dissected areas of the uplands. It consists mainly of Winifred clay loam and Utica soils that are so intermingled that they cannot be shown separately on the soil map.

Winifred clay loam makes up 50 to 80 percent of this complex, and Utica soils make up 20 to 50 percent. Pierre clay and Promise clay together amount to 10 to 20 percent of some mapped areas. Pierre clay is on knolls below the crests of benches, and Promise clay is on side slopes. The Utica soils occur mostly on the crests and partly on knolls and the tiny remnants of benches below bench edges. They are generally gravelly and have a thinner surface layer than is typical of Utica soils. The Winifred clay loam occurs in the middle and lower parts of slopes. It is less deep to shale than is typical of Winifred soils. Very small seeps occur in some areas.

This complex is too steep and dissected for cultivation. It is suited to range, but the complex as a whole produces only fair yields of forage. The Winifred soil produces much higher yields of forage than the Utica soils, which are droughty. The most desirable grasses can be maintained by good range management. (Winifred part: capability unit VIe–3; Thin Clayey range site. Utica part: capability unit VIe–6; Thin Clayey range site)

Woodhurst Series

The Woodhurst series consists of very dark colored stony loams that are underlain by igneous rock. These soils are on moderately steep and steep slopes in mountainous areas. They developed under a dense cover of mid and tall grasses.

The Woodhurst soils are noncalcareous throughout. They have a dark grayish-brown to very dark grayish-brown surface layer that is about 1 foot thick. The blocky subsoil is brown to dark grayish brown and about 1 foot thick. It merges with the underlying igneous rock from which the stony loam or stony clay loam parent material weathered.

The surface layer is single grained or has fine, crumb structure. By volume, the stones amount to 20 to 40 percent of the surface layer and 50 to 60 percent of the subsoil. Depth to bedrock ranges from 15 to 36 inches, but the bedrock is weathered, and moisture penetrates into the cracks and crevices to a depth of 3 feet to several feet.

These soils take in water moderately rapidly, are well drained, and have fair moisture-storage capacity. The supply of organic matter is good.

The Woodhurst soils have a thicker, darker colored surface layer than the Blaine soils and are noncalcareous throughout. Blaine soils have accumulated lime just below the subsoil. Woodhurst soils have a higher percentage of stone than the Teton soils, which developed from sandstone instead of igneous rock.

Woodhurst stony loam (8 to 50 percent slopes) (Wo).—This soil occurs in rolling to hilly, mountainous areas. Its

profile is like the one described as typical of the Woodhurst series.

Included on the crests of steep slopes in areas mapped as this soil are small areas of Spring Creek stony loam.

Woodhurst stony loam is too stony and, in many places, too steep for cultivation. It is well suited to range and produces good yields of desirable grasses if management is good. (Capability unit VIIs–1; Silty range site, 20 to 24 inches precipitation)

Woodhurst-Alder stony complex (4 to 35 percent slopes) (Wp).—This complex is in the foothills of the Highwood Mountains on uneven, moderately steep or steep slopes. It consists mainly of Woodhurst and Alder soils that are so intermingled that they cannot be shown separately on the soil map.

The Woodhurst soils and Alder soils each make up 40 to 50 percent of any mapped area. Spring Creek stony loam makes up 5 to 10 percent of some mapped areas and occurs on ridges and crests. Rock crops out in very small areas on ridges. The Woodhurst soils generally are stony loams, and they occupy ridges, mounds, and small round hills. Their profile is like the one described as representative of the Woodhurst series. The Alder soils are generally clay loam and stony clay loam; they occur in the lower areas. The clay loam has a profile that is similar to the one described as representative of the Alder series.

This complex is too stony for cultivation, but as a whole, it produces good yields of desirable grasses if the range is properly managed. Because the Alder soils are less stony and store more moisture than the Woodhurst soils, they produce a little more forage. The Spring Creek soil is droughty. (Capability unit VIIs–1; Silty range site, 20 to 24 inches precipitation)

Woodhurst-Loberg complex (15+percent slopes) (Wr).—This complex consists mainly of Woodhurst and Loberg soils in small areas that are transitional between woodland and grassland. These areas are on steep, hilly slopes of the Little Belt Mountains. These soils are so intermingled that they cannot be shown separately on the soil map.

Woodhurst stony loam makes up 25 to 50 percent of the complex; Loberg stony loam, 50 to 60 percent; and Cowood stony loam, 5 to 15 percent. The Loberg soil is in densely wooded areas, and the Woodhurst soil is in grassed areas that have open stands of timber intermingled throughout. The Cowood stony loam is also in grass and occupies the crests of steep slopes. The Woodhurst soil has a profile that is similar to the one described as representative of its series. The Loberg soil has thinner layers and a less clayey and less blocky subsoil than is normal for Loberg soils, and it is less deep to bedrock.

This complex is too steep and stony for cultivation, but it is suited to range and trees. The Woodhurst soil can produce good yields of desirable forage plants if the range is properly managed. The Loberg soil supports a good stand of lodgepole pine and Douglas-fir. (Woodhurst part: capability unit VIIs–1; Silty range site, 20 to 24 inches precipitation. Loberg part: capability unit VIe–7; no range site assigned)

Woodhurst-Spring Creek stony complex (8+ percent slopes) (Ws).—This complex is in the choppy foothills immediately below the Highwood Mountains. It consists mainly of Woodhurst stony loam and Spring Creek stony loam that are so intermingled that they cannot be shown separately on the soil map.

The Woodhurst soil and the Spring Creek soil each make up 40 to 50 percent of most mapped areas. Castle clay and Cheadle stony loam together amount to 5 to 20 percent of some mapped areas. Outcrops of shale and rocks are in some small areas. The Spring Creek stony loam is on the ridges, crests, and upper parts of hills, and the Woodhurst stony loam is on the lower slopes and in saddles and swales. The Woodhurst soil and the Spring Creek soil each have a profile like the one described as representative of its respective series.

This complex is too steep and stony for cultivation. It is used for range and can be kept in the most desirable grasses if range management is good. The Woodhurst soil produces higher yields than the shallow Spring Creek soil. (Woodhurst part: capability unit VIIs–1; Silty range site, 20 to 24 inches precipitation. Spring Creek part: capability unit VIIs–2; Shallow range site)

Woodhurst-Teton-Cheadle soils (15+ percent slopes) (Wt).—This complex is high in the Highwood Mountains on smooth, round, steep slopes. It consists mainly of Woodhurst soils, Teton soils, and Cheadle soils that are so intermingled that they cannot be shown separately on the soil map.

Woodhurst stony loam makes up 30 to 40 percent of this complex; Teton channery loam and stony loam, 25 to 35 percent; Cheadle stony loam, 20 to 30 percent. Spring Creek stony loam accounts for 5 to 15 percent of some mapped areas. The soils in this complex developed mainly from weathered igneous rock and sandstone. Woodhurst stony loam overlies igneous rock and has a profile similar to the one described as representative of the Woodhurst series. The Teton and Cheadle soils are in areas where material weathered from sandstone is intermingled with material weathered from igneous rock. The Teton soils are channery loam and stony loam. The Cheadle soil is stony loam and occurs on ridges. Except for texture and the underlying sandstone, the Teton and Cheadle soils have profiles similar to the ones described as representative of their respective series. In this complex the sandstone underlying the Teton and Cheadle soils has been under extreme heat and pressure and is, therefore, semimetamorphosed to quartzite.

This complex is too steep and stony for cultivation, but it is suited to range. Under good range management, desirable plants can be maintained and fairly good yields of forage produced. The Cheadle soil is more droughty than the Woodhurst and Teton soils and produces lower yields. (Woodhurst part: capability unit VIIs–1; Silty range site, 20 to 24 inches precipitation. Teton part: capability unit VIs–1; Silty range site, 20 to 24 inches precipitation. Cheadle part: capability unit VIIs–2; Silty range site, 20 to 24 inches precipitation)

Use and Management of Soils

This section discusses the use and management of soils for dryland and irrigated crops, for range, for trees and shrubs in woodland and windbreaks, and for wildlife. It also describes soil characteristics important to engineering and gives information that is helpful in engineering work.

Use and Management of Soils for Dryland Crops [1]

About 85 percent of the cropland in the survey area is used for small grain. Wheat, barley, and oats are grown, but wheat occupies by far the largest acreage. The acreage in oats is small. Both winter wheat and spring wheat are grown, but in recent years two-thirds of the acreage in wheat has been in spring wheat.

This subsection has four main parts. The first part discusses general practices used in managing soils for dryland crops. The second part explains capability classification and describes the classes, subclasses, and units of soils used for dryland crops. In the third part each capability unit is described, its soils are listed, and its management is discussed. In the fourth part yields of the principal dryland crops in the survey area are predicted under two levels of management.

General practices of management

To be permanent, any system of agriculture must be profitable and at the same time keep the soils capable of continuous productivity. In the survey area the practices used on the soils in dryland crops are for the purpose of conserving moisture, controlling erosion, improving tilth, and maintaining fertility and the supply of organic matter. Some practices accomplish more than one purpose. Practices commonly used in the survey area are discussed in the following paragraphs.

CONTROLLING EROSION AND CONSERVING MOISTURE

Soil losses are low if living plants, or their residue, is kept on the fields. Except in areas of higher rainfall, small grain is grown in alternate years so that moisture is conserved. During the fallow season, the field is cultivated to control weeds. If fodder or silage can be used to advantage, corn may be economically susbstituted for fallow.

Tillage should be planned so that enough stubble is left on the ground to prevent erosion and yet at seeding time is not so heavy that it prevents a drill from operating easily. This practice is called stubble mulching. The amount of residue needed for protection varies with the kind of soil. Implements with blades, shovels, or sweeps are effective in keeping residue on the surface.

The effectiveness of stubble mulching depends on the choice of tool; the speed, depth, and spacing of the tilling; and the moisture content, texture, and compaction of the soil. Enough residue must be left on the surface to protect it. Otherwise, emergency tillage is required to make a cloddy or ridged surface that resists soil blowing. More specific information on stubble mulching can be obtained from the county agent and technicians of the Soil Conservation Service.

Fields can be further protected by farming in alternate strips of crops and fallow. Then through much of each year the land is protected, and in a year following a severe drought, when little stubble is produced, a field receives more protection than it would if strips of crops were not alternated with strips of fallow. The strips are run as nearly perpendicular to the prevailing wind as is practical. They average about 10 rods in width, but the width varies with the kind of soil and the position of the field.

On moderate slopes, contour strips reduce runoff and the loss of soil and, by allowing more moisture to infiltrate the soil, conserve moisture. The strips are separated by grassed buffer strips that are at least 1 rod wide. These buffer strips are generally placed in odd areas where the slope breaks. The grass can be cut for hay or can be grazed in spring and fall.

Watercourses, or waterways, are planted to suitable grasses to prevent gullies from forming. If a waterway originates outside of a field but runs through it, the waterway can be planted to suitable grasses so that gullies do not form. Whenever grassed waterways are crossed by tillage implements, the implements must be raised. If runoff originates on a field, erosion must be controlled on the entire field by stubble mulching, stripcropping, establishing grass cover, or other means. Most of the time grass or a grass-legume mixture should be kept on soils that have steep slopes, low natural fertility, low moisture-storage capacity, and a texture that makes the soils susceptible to blowing.

SUITABLE CROPPING SYSTEMS

The kind of cropping system, or rotation, commonly used in the survey area depends on the amount of rainfall normally received and the kind of crops needed. Most farmers follow a small grain-fallow system in areas where less than 18 inches of precipitation per year is normally received. This system is good if suitable practices are used to control erosion. If livestock are raised, however, the farmer may find that corn in alternate years is more profitable than fallow.

In areas normally receiving more than 18 inches of precipitation, a 3-year rotation of small grain-small grain-fallow can be used. The soils are improved if sweetclover is planted with the small grain in the second year and is plowed under for green manure early in the fallow year.

In tests at the Central Montana Branch of the Montana Experiment Station at Moccasin, the rotation that produced the highest yields was fallow-barley-spring wheat-corn. After a year of fallow, barley was planted and harvested. The field was plowed in spring and planted to wheat. After the wheat was harvested in fall, stubble remained until the following spring, and then the field was planted to corn.

MAINTAINING FERTILITY

The virgin soils in the survey area have enough natural plant nutrients for plant growth, but fields that have been cropped for many years are deficient in some nutrients, notably phosphorus and nitrogen. If cropping continues on soils that have been cropped for a long time, shortages of other nutrients are likely.

Moderate additions of phosphate increase the yields of small grain if the supply of moisture is adequate for good crop growth. Additions of nitrogen, however, have not increased yields of wheat after summer fallow in tests at the Moccasin Experiment Station. Apparently, as much nitrogen as the wheat can use builds up during the fallow period. The wheat does not use much nitrogen, because only a small amount of moisture is available. All fertilizer for small grain should be applied in bands at the

[1] By WENDELL THACKER, agronomist, Soil Conservation Service.

level of the seed or immediately below it. Broadcasting the fertilizer has not been effective.

Legumes use a large amount of phosphate, but a supply that will last several years can be worked into the soil before seeding. The soils should be tested to determine the need for phosphate.

Dryland grasses respond to additions of nitrogen, particularly if the grasses are planted in wide rows and seed is harvested. Moderate additions of phosphate are also needed for good yields of grass.

Deficiencies in potassium and minor nutrients have not been observed in the survey area.

Capability groups of soils

The capability classification is a grouping that shows, in a general way, how suitable soils are for most kinds of farming or for other uses. It is widely used by farmers and ranchers in planning how their land will be used and how to conserve soil and water. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. Eight capability classes are in the broadest grouping and are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The grouping of soils for dryland farming differs from that for irrigated farming. The descriptions of the classes, subclasses, and units that follow are for dryland. The term "dryland" appears only in the name of the capability units in classes II, III, and IV because the units in classes V, VI, VII, and VIII are not cultivated. Descriptions of the grouping for irrigated farming are in the subsection "Use and Management of Soils for Irrigated Crops."

CAPABILITY GROUPS OF DRYFARMED SOILS

Class I. Soils that have few limitations that restrict their use. (None in the survey area)

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Capability unit IIe–1, dryland.—Deep, dark-colored loams and clay loams mainly on gentle slopes.
  - Capability unit IIe–2, dryland.—Deep, dark-colored, gravelly or cobbly clay loams on nearly level to gentle slopes.
  - Capability unit IIe–3, dryland.—Deep, dark-colored clays and silty clays on nearly level to gentle slopes.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Capability unit IIw–1, dryland.—Deep, dark-colored, imperfectly drained loams and clay loams on low flood plains.
- Subclass IIc. Soils with moderate climatic limitations.
  - Capability unit IIc–1, dryland.—Deep, black loams and silt loams on gentle slopes.
  - Capability unit IIc–2, dryland.—Deep, dark-colored, well-drained loams to silty clay loams on nearly level slopes.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Capability unit IIIe–1, dryland.—Black, loamy soils that are moderately deep on rolling uplands and deep on sloping fans.
  - Capability unit IIIe–2, dryland.—Dark-colored, loamy soils that are moderately deep on rolling uplands and deep on sloping fans.
  - Capability unit IIIe–3, dryland.—Dark-colored, granular clays and silty clays on rolling uplands and sloping fans.
  - Capability unit IIIe–4, dryland.—Dark-colored, loamy soils that are moderately deep to shallow on rolling uplands and gravelly soils on sloping fans and benches.
  - Capability unit IIIe–5, dryland.—Nearly level to sloping soils that have a thick, black surface layer and a claypan.

Subclass IIIw. Soils that have severe limitations because of excess water.
Capability unit IIIw–1, dryland.—Deep, poorly drained soils that are generally moderately wet.
Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
Capability unit IIIs–1, dryland.—Dark-colored soils that have a moderately thick loamy surface layer and a claypan.
Capability unit IIIs–2, dryland.—Moderately deep, dark-colored clay loams underlain by gravel on nearly level or gentle slopes.
Capability unit IIIs–3, dryland.—Deep, dark or very dark colored cobbly or gravelly loams or clay loams on nearly level or gentle slopes.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
Capability unit IVe–1, dryland.—Black loams and clay loams that are moderately deep on strongly rolling uplands and deep on moderately steep fans.
Capability unit IVe–2, dryland.—Dark-colored clay loams, cobbly clay loams, and channery loams that are moderately deep on rolling uplands and deep on moderately steep fans.
Capability unit IVe–3, dryland.—Black or very dark colored, granular, sloping and moderately rolling clays.
Capability unit IVe–4, dryland.—Dark-colored, granular, rolling clays and cobbly clays.
Capability unit IVe–5, dryland.—Moderately deep to shallow, loamy soils on rolling uplands and gravelly soils on moderately steep slopes.
Capability unit IVe–6, dryland.—Dark to moderately light colored, droughty loams and clay loams that have a thin surface layer and are on gentle to moderate slopes.
Capability unit IVe–7, dryland.—Dark to moderately light colored, moderately deep, granular clays on rolling uplands.
Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.
Capability unit IVw–1, dryland.—Deep, dark-colored, poorly drained soils on nearly level or gentle slopes.
Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.
Capability unit IVs–1, dryland.—Soils that have a thin surface layer and a claypan.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.
Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
Capability unit Vw–1.—Loams and clay loams with a high water table that is impractical to lower.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.
Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
Capability unit VIe–1.—Deep and moderately deep, black loams, clay loams, and channery clay loams on strong and steep slopes.
Capability unit VIe–2.—Black, granular clays on rolling uplands.
Capability unit VIe–3.—Moderately dark colored clays and dark colored heavy clay loams on steep slopes.
Capability unit VIe–4.—Dark-colored light clay loams on steeply rolling uplands.
Capability unit VIe–5.—Dark-colored, shallow, channery, loamy soils on steep and moderately steep slopes.
Capability unit VIe–6.—Loams that are clayey, gravelly, cobbly, or channery over clay loam shale or beds of pebbles mixed with material finer than sand.
Capability unit VIe–7.—Deep and moderately deep, light-colored loams and clay loams on strong or steep slopes.
Capability unit VIe–8.—Dispersed clays and soils that have a thin surface layer and a claypan.
Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.
Capability unit VIw–1.—Deep clays and loamy soils that are poorly drained, likely to overflow, or both.
Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.
Capability unit VIs–1.—Deep and moderately deep, black stony loams and stony clay loams on moderate to steep slopes.
Capability unit VIs–2.—Moderately deep, dark-colored stony loams and stony clay loams on nearly level to moderate slopes.
Capability unit VIs–3.—Dark-colored, gently sloping gravelly loams that are on nearly level to gently sloping benches, have a thin surface layer, and are shallow over cemented pebbles.
Capability unit VIs–4.—Poorly drained, saline soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, or wildlife.
Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.
Capability unit VIIs–1.—Moderately deep, black stony loams on moderate to steep slopes.
Capability unit VIIs–2.—Shallow, dark-colored stony loams on moderate to steep slopes.
Capability unit VIIs–3.—Shallow and very shallow cobbly alluvial land.
Capability unit VIIs–4.—Thin, strongly sloping to steep clays that are underlain by clay shale.
Capability unit VIIs–5.—Nearly barren, dispersed, strongly saline soils.

Capability unit VIIs-6.—Shallow to moderately deep, light-colored, stony, loamy soils on steep, wooded slopes.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIs. Rock or soil materials that have little potential for production of vegetation.

Capability unit VIIIs-1.—Barren shale, sandstone, limestone, and igneous rock in rough terrain.

Management by dryland capability units

In this subsection each capability unit is described and soils that make up the unit are listed. Soil qualities, such as rate of water intake and water-storing capacity, hazard of erosion, or other limitations are discussed. Some of the suitable crops and cropping systems that particularly fit each group of soils are mentioned.

CAPABILITY UNIT IIe-1, DRYLAND

This capability unit consists of deep, dark-colored loams and clay loams on slopes that range from 0 to 4 percent. The soils are—

Danvers clay loam, 2 to 4 percent slopes.
Danvers-Judith clay loams, 2 to 4 percent slopes.
Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes.
Fergus clay loam, 2 to 4 percent slopes.
Judith clay loam, 2 to 4 percent slopes.
Savage silty clay loam, 2 to 4 percent slopes.
Straw clay loam, 2 to 4 percent slopes.
Twin Creek loam, 2 to 4 percent slopes.
Winifred clay loam, 0 to 4 percent slopes.

These soils take in water readily, and they can hold about 6 inches of available moisture in the top 3 feet. Their natural fertility is high. The small amount of rainfall is the main limitation to production. The soils are susceptible to wind erosion and, because of their slopes, are moderately susceptible to water erosion.

Crops suited to these soils are small grain, alfalfa, corn for fodder and silage, and native and tame grasses. Trees and shrubs planted for windbreaks grow well.

Alternating small grain and fallow, stripcropping, and stubble mulching are practices that control erosion and weeds, store moisture, and maintain crop yields. Crop residues left on or near the surface help to maintain the organic-matter content and to protect these soils from wind erosion.

CAPABILITY UNIT IIe-2, DRYLAND

This capability unit consists of deep, dark-colored, well-drained cobbly clay loams and gravelly clay loams that are nearly level or gently sloping. Slopes range from 0 to 4 percent. Enough pebbles and cobblestones are on the surface and in the surface layer to make tilling and harvesting difficult. The soils are—

Danvers cobbly clay loam, 0 to 4 percent slopes.
Danvers gravelly clay loam, 0 to 4 percent slopes.
Danvers-Judith gravelly clay loams, 0 to 2 percent slopes (Danvers part).
Judith-Danvers gravelly clay loams, 0 to 4 percent slopes (Danvers part).

These soils absorb water readily, and they can store about 4 inches of available moisture in the top 2 feet of soil and an additional inch in the third foot. The cobblestones and pebbles slightly reduce the amount of moisture these soils can store, as well as hinder tilling and harvesting. Natural fertility is high, but the soils are moderately susceptible to wind erosion.

Small grain, alfalfa, and tame and native grasses are suitable crops. Trees and shrubs planted for windbreaks grow well.

Alternating grain and fallow, stripcropping, and stubble mulching are practices that control erosion, store moisture, and increase yields. Crop residues on or near the surface protect these soils from wind erosion.

CAPABILITY UNIT IIe-3, DRYLAND

The soils in this capability unit are deep, dark-colored, well-drained clays or silty clays on nearly level to gentle slopes. They are—

Beckton-Savage complex (Savage part).
Promise clay, 0 to 2 percent slopes.
Savage silty clay, 0 to 2 percent slopes.
Savage silty clay, 2 to 4 percent slopes.
Terrad silty clay, 0 to 2 percent slopes.

These soils absorb water slowly but have excellent moisture-storage capacity. They can store 6 to 7 inches of available moisture in the top 3 feet of soil. Their natural fertility is high. Because they are clayey, however, tilling is difficult when the soils are too dry or too moist and should not be done unless the content of moisture is good. Wind erosion is likely.

Suitable crops are small grain, corn for fodder or silage, alfalfa, and tame and native grasses.

A small grain alternated with fallow, stripcropping, and stubble mulching helps to control erosion, store moisture, control weeds, and increase yields. Crop residues left on or near the surface help to maintain organic-matter content and to protect these soils from wind erosion.

CAPABILITY UNIT IIw-1, DRYLAND

This capability unit consists of deep, dark-colored, imperfectly drained loams and clay loams on low flood plains. These soils have a water table that fluctuates between depths of 2 and 5 feet. They are—

Gallatin clay loam.
Gallatin loam.
Slocum loam.

These deep, loamy soils, in addition to having a water table that is sometimes high, are likely to be flooded occasionally. They are high in fertility and organic-matter content. They can hold 5 or 6 inches of available moisture in the top 3 feet of soil. The soils are used mainly to produce hay with or without irrigation. Although the water table is generally beneficial, if it stays within 2 to 4 feet of the surface for long periods, alfalfa is short lived.

Suitable crops are mixed hay, native grasses on range, tame pasture, alfalfa, and small grain.

A rotation of 2 years of a small grain followed by 3 to 5 years of hay is desirable for maintaining yields and controlling weeds. A hay mixture that produces well is one that includes adapted grasses, alfalfa, and another legume less affected by the water table. Since the water table varies, each plant in this mixture grows well when the water table is at a depth suited to the plant. The water

table is generally beneficial. Most areas can be drained by open ditches or tile lines. Suitable for drained areas are cropping systems and irrigation methods used on deep, well-drained soils.

CAPABILITY UNIT IIc-1, DRYLAND

This unit consists of deep, black loams and silt loams on gentle slopes of the foothills where the growing season is short. The soils are—

Adel silt loam, terrace.
Bridger loam, 2 to 4 percent slopes.
Raynesford and Adel loams, 2 to 4 percent slopes.

These soils have a high organic-matter content in their virgin state. They take in water readily and can store about 6 inches of available moisture in the top 3 feet of soil. Some areas of these soils are exposed to wind erosion.

Small grain, alfalfa, and native and tame grasses are suitable crops. Trees and shrubs can be grown in windbreaks or for esthetic purposes.

A small grain grown for 1 or 2 years and followed by 1 year of fallow in a stripcropping system helps to control erosion, control weeds, store moisture, and maintain yields. The content of nitrogen and of organic matter can be maintained by seeding clover with the second year of grain and plowing it under the following June. Because these soils have a short growing season, farm operations should be timely.

CAPABILITY UNIT IIc-2, DRYLAND

This capability unit consists of deep, dark-colored, well-drained loams to silty clay loams on nearly level slopes. The soils are—

Beckton-Danvers clay loams (Danvers part).
Danvers clay loam, 0 to 2 percent slopes.
Danvers-Judith clay loams, 0 to 2 percent slopes.
Fergus clay loam, 0 to 2 percent slopes.
Judith clay loam, 0 to 2 percent slopes.
Savage silty clay loam, 0 to 2 percent slopes.
Straw clay loam, 0 to 2 percent slopes.
Twin Creek clay loam, 0 to 2 percent slopes.

These soils take in water readily and can hold about 6 inches of available moisture in the top 3 feet of soil. Their natural fertility is high. The amount of rainfall is small and is the main factor that limits production. Wind erosion is likely.

Suitable crops are small grain, alfalfa, corn for fodder or silage, and native and tame grasses. Trees and shrubs can be grown in windbreaks or for esthetic purposes.

Alternating small grain and fallow, stripcropping, and stubble mulching are desirable for controlling erosion, controlling weeds, storing moisture, and maintaining yields. Crop residues left on or near the surface help to maintain organic-matter content and to protect these soils from erosion.

CAPABILITY UNIT IIIe-1, DRYLAND

This capability unit consists of black loams and clay loams that are more than 4 feet deep on fans and are 2 to 4 feet deep over limestone, shale, and sandstone on uplands. Slopes generally range from 2 to 8 percent. The soils are—

Adel loam, 2 to 8 percent slopes.
Alder clay loam, 2 to 8 percent slopes.
Alder-Maginnis channery clay loams, 2 to 8 percent slopes (Alder part).
Raynesford and Adel loams, 4 to 8 percent slopes.
Skaggs clay loam, 4 to 8 percent slopes.
Teton loam, 2 to 8 percent slopes.
Teton-Cheadle channery loams, 4 to 15 percent slopes (Teton part).

In undisturbed areas these black soils have a high content of organic matter. They take in water readily and can hold about 6 inches of available moisture in the top 3 feet. Some areas are susceptible to wind erosion. Because of their slope, these soils are easily eroded where snow melts rapidly or rains are intense.

Small grain, alfalfa, and native and tame grasses are suitable crops. Trees and shrubs planted for windbreaks and for esthetic purposes grow well.

If a small grain is grown for 2 years in contour strips and is followed by 1 year of fallow, erosion and weeds are controlled, moisture is stored, and yields are maintained. The content of organic matter and nitrogen can be maintained by sowing clover in the small grain during the second year and plowing it under in June. Timely farm operations are especially important because the growing season is short.

CAPABILITY UNIT IIIe-2, DRYLAND

In this capability unit are dark-colored, loamy soils that are clayey, silty, channery, or cobbly in some places. These soils are more than 4 feet deep on fans and terraces and are 2 to 4 feet deep on uplands, where they are underlain by shale, sandstone, or igneous rock. They are mainly on slopes of 4 to 8 percent. The soils are—

Absarokee clay loam, 2 to 8 percent slopes.
Absarokee-Cheadle channery loams, 2 to 8 percent slopes (Absarokee part).
Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes (Absarokee part).
Chama clay loam, 4 to 8 percent slopes.
Chama-Midway clay loams, 4 to 8 percent slopes (Chama part).
Danvers clay loam, 4 to 8 percent slopes.
Danvers cobbly clay loam, 4 to 8 percent slopes.
Darret-Cheadle complex, 2 to 8 percent slopes (Darret part).
Fergus clay loam, 4 to 8 percent slopes.
Fergus silty clay loam, shale substratum, 2 to 8 percent slopes.
Judith clay loam, 4 to 8 percent slopes.
Judith and Savage soils.
Savage silty clay loam, 4 to 8 percent slopes.
Twin Creek loam, 4 to 8 percent slopes.
Winifred clay loam, 4 to 8 percent slopes.
Winifred cobbly clay loam, 2 to 8 percent slopes.
Winifred-Rhoades clay loams (Winifred part).

These soils take in water readily and can store about 6 inches of available moisture in the top 3 feet of soil. Their natural fertility is high. The soils are moderately susceptible to wind erosion. Because of their slope, they are susceptible to water erosion, particularly when rains are heavy or when snow melts rapidly.

These soils are suited to small grain, alfalfa, and tame and native grasses. Trees and shrubs planted in windbreaks or for esthetic purposes can be grown successfully.

Alternating grain and fallow, stripcropping, and stubble mulching are desirable in controlling erosion, storing moisture, and increasing yields. To keep the precipitation where it falls, tillage operations should be on the contour wherever feasible. Keeping the crop residues on or near the surface is necessary for protecting these soils from wind and water erosion.

CAPABILITY UNIT IIIe-3, DRYLAND

The soils in this capability unit are dark-colored, granular clays and silty clays that are more than 4 feet deep on

sloping fans and are 2 to 4 feet deep over shale on rolling uplands. The soils are—

Absarokee silty clay, 2 to 8 percent slopes.
Promise clay, 2 to 8 percent slopes.
Savage silty clay, 4 to 8 percent slopes.
Terrad clay, 2 to 8 percent slopes.

These fine-textured, granular, clayey soils absorb water slowly and are susceptible to blowing. They can store 6 or 7 inches of available moisture in the top 3 inches of soil. Because they are sloping, water erosion is a serious problem, especially during heavy rains.

Suitable crops are small grain, alfalfa, and tame and native grasses.

If a small grain is alternated with fallow, stripcropping and stubble mulching are effective in lessening erosion and in controlling weeds. Where feasible, contour strips and grassed buffers help reduce runoff and erosion and insure better yields over long periods.

CAPABILITY UNIT IIIe-4, DRYLAND

This capability unit consists of dark-colored, loamy soils that are 15 to 30 inches deep over shattered sandstone or igneous rock and gravelly loams that are about the same depth over pebbles mixed with material finer than sand. These soils are on rolling uplands or sloping fans and benches. The soils are—

Blaine-Spring Creek loams, 2 to 8 percent slopes.
Cheadle loam, 2 to 8 percent slopes.
Judith gravelly clay loam, 4 to 8 percent slopes.
Judith-Utica gravelly loams, 4 to 8 percent slopes (Judith part).

These soils absorb water readily but are somewhat droughty. They can store 2 to 4 inches of available moisture in the loamy material above the gravel or the fractured sandstone. They are moderately susceptible to wind erosion and highly susceptible to water erosion.

Small grain, alfalfa, and native and tame grasses are suitable crops.

To lessen erosion, control weeds, and maintain yields, use contour stripcropping, stubble mulching, and a cropping system in which 1 or 2 years of a small grain is alternated with 1 year of fallow. Crop residues left on or near the surface help to protect these soils from erosion.

CAPABILITY UNIT IIIe-5, DRYLAND

In this capability unit are nearly level to sloping soils that have a thick, black surface layer and a claypan. The soils are—

Blythe loam, 2 to 4 percent slopes.
Blythe loam, 4 to 8 percent slopes.

These soils have a fairly good supply of organic matter. They can store about 6 inches of available moisture in the top 3 feet of soil. The loamy surface layer takes in water readily, but the underlying claypan is slowly permeable. Because of the claypan, runoff is considerable during heavy or prolonged rains. Water erosion is a problem, particularly on the 4 to 8 percent slopes.

Small grain, alfalfa, and native and tame grasses are suitable crops.

Effective practices to reduce erosion, control weeds, store moisture, and maintain yields are stripcropping and stubble mulching and a cropping system in which 2 years of a small grain are followed by 1 year of fallow. In addition, contour tillage and crop residues left on or near the surface help to lessen runoff on the slopes of 4 to 8 percent.

CAPABILITY UNIT IIIw-1, DRYLAND

This capability unit consists of deep, dark-colored, poorly drained soils that are silty clay to loam and are generally moderately wet. The soils are—

Bowdoin silty clay, low clay variant.
Colvin-Lamoure clay loams.
Gallatin loam, clay substratum.

These soils have a high content of organic matter. The choice of crops is limited by the fluctuating water table, which is generally within 4 feet of the surface and averages about 2½ feet. Drainage is needed in many areas before these soils can be cultivated, but without drainage, good pasture can be produced, for it benefits from subirrigation.

Suitable crops are mixed hay, native and tame grasses, and where the water table is more than 2½ feet below the surface, small grain. Because of the high water table, alfalfa does not grow well.

A suitable cropping system that controls weeds, restores nitrogen, and maintains yields is 5 to 7 years of grass-legume hay followed by 2 years of a small grain.

CAPABILITY UNIT IIIs-1, DRYLAND

The soils in this capability unit have a dark-colored, moderately thick, loamy surface layer and a claypan. Slopes are generally 0 to 4 percent. The soils are—

Beckton loam.
Beckton-Arvada clay loams (Beckton part).
Beckton-Danvers clay loams (Beckton part).
Beckton-Savage complex (Beckton part).
Winifred-Rhoades clay loams (Rhoades part).

Because of their claypan, these soils absorb water slowly. They can store about 6 inches of available moisture in the top 3 feet of soil. Some water is lost in runoff, however, because the rate of water intake is slow. The growth of roots is impeded by the claypan and by the variable amounts of salt in the lower subsoil.

Suitable crops are grass-legume hay, small grain, and native and tame grasses.

If a small grain-fallow sequence is used, stripcropping and good stubble mulching help to control erosion, store moisture, and control weeds. Contour strips are needed on slopes of more than 4 percent. Crop residues left on or near the surface help to control wind and water erosion.

CAPABILITY UNIT IIIs-2, DRYLAND

This capability unit consists of dark-colored clay loams that are underlain at a depth of 18 to 30 inches by mixed gravel and sand or very gravelly sandy loam. Slopes are generally 0 to 2 percent. The soils are—

Judith clay loam, low terrace.
Straw clay loam, gravelly substratum.

These soils take in water readily, but their moisture storage capacity is moderately low. They can store only 3 to 5 inches of available moisture, the amount depending on the depth to the underlying gravel. Crops on these soils are more dependent on rainfall received during the growing season than are crops on deeper soils that have more moisture-storage capacity. Wind erosion is likely.

Suitable crops are small grain, alfalfa, corn for fodder and silage, and native and tame grasses. Trees and shrubs

grown in windbreaks and for esthetic purposes send their roots down to moisture that is deep in the profile.

By alternating crops and fallow and by using stripcropping and stubble mulching, a limited amount of moisture can be stored in these soils. In addition, these practices lessen wind erosion and help to maintain yields. Crop residues left on or near the surface are effective in controlling wind erosion.

CAPABILITY UNIT IIIs-3, DRYLAND

This capability unit consists of dark or very dark colored cobbly or gravelly loams or clay loams that are underlain at a depth of 5 to 30 inches by pebbles mixed with material finer than sand. Slopes are nearly level or gentle. The soils are—

Danvers-Judith gravelly clay loams, 0 to 2 percent slopes (Judith part).
Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Judith part).
Judith cobbly clay loam, 0 to 4 percent slopes.
Judith cobbly clay loam, low terrace, 0 to 4 percent slopes.
Judith gravelly clay loam, 0 to 2 percent slopes.
Judith gravelly clay loam, 2 to 4 percent slopes.
Judith gravelly clay loam, low terrace, 0 to 4 percent slopes.
Judith-Danvers gravelly clay loams, 0 to 4 percent slopes (Judith part).

These soils absorb water readily but are somewhat droughty. They can store 2 to 4 inches of available moisture in the fine material and about ½ inch in the top foot of the gravelly material. Some of these soils have on the surface pebbles and cobblestones that give some protection, but the soils are moderately susceptible to wind erosion.

These soils are suited to small grain, mixed grass-legume hay, corn for fodder and silage, and native and tame grasses. Trees and shrubs can also be grown in windbreaks.

Desirable for reducing erosion, controlling weeds, and maintaining yields is a cropping system in which 1 or 2 years of a small grain is followed by a year of fallow and in which stripcropping and stubble mulching are used. Crop residues kept on or near the surface help to keep wind and water erosion to a minimum.

CAPABILITY UNIT IVe-1, DRYLAND

This capability unit consists of black loams and clay loams that are 20 to 40 inches deep over sandstone and shale on the uplands and are more than 4 feet deep on the fans. In most places slopes range from 8 to 15 percent. The soils are—

Adel loam, 8 to 18 percent slopes.
Alder clay loam, 8 to 15 percent slopes.
Bridger loam, 4 to 15 percent slopes.
Raynesford and Adel loams, 8 to 15 percent slopes.
Teton loam, 8 to 15 percent slopes.

These black, loamy soils have a high content of organic matter, and they absorb water readily. They can store about 6 inches of available moisture in the top 3 feet of soil. Because of their slopes, these soils are susceptible to water erosion if they are cultivated.

Suitable crops for these soils are small grain, alfalfa, and native and tame grasses.

If a small grain is grown for 1 or 2 years and is followed by 1 year of fallow, stubble mulch and contour strips with grassed buffers are most effective in lessening water erosion, storing moisture, controlling weeds, and maintaining yields. Crop residues on or near the surface help to prevent washing. Timely farm operations are needed because the growing season is short.

CAPABILITY UNIT IVe-2, DRYLAND

This capability unit consists of dark-colored, sloping and strongly sloping clay loams, cobbly clay loams, and channery loams. These soils are 20 to 40 inches deep over shale and sandstone on uplands and more than 4 feet deep on fans. They are—

Absarokee clay loam, 8 to 15 percent slopes.
Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded (Absarokee part).
Chama-Midway clay loams, 8 to 15 percent slopes (Chama part).
Danvers cobbly clay loam, 8 to 15 percent slopes.
Darret clay loam, 8 to 15 percent slopes.
Fergus clay loam, 8 to 15 percent slopes.
Winifred clay loam, 8 to 15 percent slopes.
Winifred cobbly clay loam, 8 to 15 percent slopes.
Winifred-Judith clay loams.

These soils absorb water at a moderately slow rate and can hold 4 to 6 inches of available moisture. Their natural fertility is high. Because of the slopes, water erosion is a very serious problem in cultivated areas.

These soils are best suited to range or pasture, but if management is good, small grain and alfalfa can be grown.

If a small grain is alternated with fallow, and contour strips, grassed buffers, and stubble mulch are used, erosion is reduced, moisture is stored, weeds are controlled, and yields are maintained. Crop residues left on or near the surface also reduce erosion.

CAPABILITY UNIT IVe-3, DRYLAND

Castle clay, 4 to 15 percent slopes, is the only soil in this capability unit. It is a black or very dark colored soil that is 18 to 40 inches deep over clay shale. Slopes are complex.

This granular clay contains only a moderate amount of organic matter. It takes in water slowly and can store 4 to 6 inches of available moisture. Because of the slopes and the slow rate of water absorption, runoff is considerable during heavy rains and when snow melts rapidly. Water erosion is a serious problem in cultivated areas. The growing season on this soil is slightly more than 95 days.

Alfalfa, native and tame grasses, and small grain are suitable crops.

Erosion is lessened, weeds are controlled, and yields are maintained by using a cropping sequence of 1 or 2 years of a small grain and 1 year of fallow, and supplementing this by contour strips and grassed buffers, and by stubble mulch. Keeping crop residues on or near the surface also helps to protect this soil from water erosion.

CAPABILITY UNIT IVe-4, DRYLAND

This capability unit consists of dark-colored, granular, rolling clays and cobbly clays that are 2 to 4 feet deep over shale. The soils are—

Promise clay, 8 to 15 percent slopes.
Promise cobbly clay.
Terrad clay, 8 to 35 percent slopes.

These dark-colored, granular clays absorb water slowly and release it slowly to plants. They can store 5 to 7 inches of available moisture. Because texture is generally

fine, the soils should be tilled only when the content of moisture is good. Because of the slopes and slow rate of water intake these soils are highly susceptible to water erosion, especially in cultivated areas.

Suitable crops are native and tame grasses, mixtures of grasses and legumes, and small grain.

Essential for controlling erosion, if a small grain-fallow cropping system is used, are contour strips, preferably with grassed buffers, and stubble mulch. These measures are also desirable for storing moisture and controlling weeds. Wind and water erosion are lessened by keeping crop residues on or near the surface.

CAPABILITY UNIT IVe-5, DRYLAND

This capability unit consists of dark-colored, loamy soils over sandstone, limestone, and soft shale, and of gravelly and nongravelly loamy soils over pebbles mixed with material finer than sand. All these soils are on uplands, and the material underlying them is at a depth of 15 to 30 inches. The soils are—

Cheadle loam, 8 to 15 percent slopes.
Judith-Utica gravelly loams, 8 to 15 percent slopes (Judith part).
Skaggs clay loam, 8 to 15 percent slopes.
Skaggs loam.
Twin Creek loam, 8 to 15 percent slopes.

These dark-colored, loamy soils have only a moderate supply of organic matter. They absorb water fairly readily and can store 2 to 4 inches of available moisture. Because of their slopes, however, these soils are highly susceptible to water erosion.

Small grain, alfalfa, and native and tame grasses are suitable crops.

Essential for preventing erosion, if a grain-fallow cropping system is used, are contour stripcropping, preferably with grassed buffers, and stubble mulching. These practices are also effective in storing moisture, controlling weeds, and maintaining yields.

CAPABILITY UNIT IVe-6, DRYLAND

This capability unit consists of dark to moderately light colored, loamy soils and gravelly or channery, loamy soils that have a thin surface layer. The loamy soils are underlain by sandstone, igneous rock, or hard or soft shale at a depth of 12 to 20 inches, and the gravelly or channery, loamy soils are underlain by pebbles mixed with material finer than sand at a depth of about 10 inches. These soils occur mainly on slopes of 2 to 8 percent. They are—

Absarokee-Cheadle channery loams, 2 to 8 percent slopes (Cheadle part).
Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes (Maginnis part).
Alder-Maginnis channery clay loams, 2 to 8 percent slopes (Maginnis part).
Bainville loam.
Chama-Midway clay loams, 4 to 8 percent slopes (Midway part).
Cheadle channery loam, 2 to 8 percent slopes.
Darret-Cheadle complex, 2 to 8 percent slopes (Cheadle part).
Judith-Utica gravelly loams, 4 to 8 percent slopes (Utica part).
Utica gravelly loam, 2 to 8 percent slopes.
Utica-Judith gravelly loams, sandy substratum.

These soils absorb water at a moderate to moderately rapid rate, but they are droughty, for they can store only 1½ to 3½ inches of available moisture. The nongravelly soils are more susceptible to erosion than are the gravelly ones.

Suitable crops are native and tame grasses, mixtures of grasses and legumes for hay and pasture, and small grain.

If a small grain is grown for 1 or 2 years and is followed by 1 year of fallow, erosion is lessened and weeds are controlled by using contour strips, preferably with grassed buffers, and stubble mulch. These practices also help to store moisture. Crop residues kept on or near the surface help to protect these soils from wind and water erosion.

CAPABILITY UNIT IVe-7, DRYLAND

Pierre clay, 2 to 8 percent slopes, is the only soil in this capability unit. It is a dark to moderately light colored, granular clay that is on gentle or moderate slopes of rolling uplands and is 30 inches deep over clay shale.

This soil absorbs water slowly and can store 3 to 5 inches of available moisture. It is difficult to work and should be tilled only when the content of moisture is good. Because of the slow rate of water intake and the fine, granular structure, both wind and water erosion are serious problems in cultivated areas.

Suitable crops are grass-legume hay, native and tame grasses, and small grain.

If a small grain-fallow cropping system is used, the combined protection of contour strips, preferably with grassed buffers, and stubble mulch helps to control erosion, store moisture, control weeds, and maintain yields. Crop residues kept on or near the surface help to protect this soil from wind and water erosion.

CAPABILITY UNIT IVw-1, DRYLAND

Fargo-Hegne silty clays are the only soils in this capability unit. They are deep, dark-colored, poorly drained soils on nearly level or gentle slopes.

These poorly drained silty clays have a fairly good supply of organic matter. Drainage, which may be difficult, is needed in most areas if these soils are cultivated. Drainage, however, may not be desirable, for in their natural condition these soils provide good subirrigated pasture. They should be tilled only when the content of moisture is good.

Without drainage, native grasses and sedges are the only suitable crops, but grass-legume hay and small grains are suitable in drained areas. Alfalfa does not last long unless these soils have been well drained.

In drained areas a suitable cropping system is 5 to 7 years of hay, 1 year of fallow, and then 1 or 2 years of a small grain. This system controls weeds, restores nitrogen, and maintains yields.

CAPABILITY UNIT IVs-1, DRYLAND

This capability unit consists of soils on fans, terraces, and to a lesser extent, on uplands. These soils have a thin surface layer and a claypan. Generally, they are intermingled with soils that have a moderately thick surface layer and a claypan. Slopes range from 0 to 6 percent. The soils are—

Arvada-Beckton cobbly clay loams.
Arvada-Laurel complex (Arvada part).
Beckton-Arvada clay loams (Arvada part).
Rhoades-Arvada complex.

These soils take in water slowly because they have a subsoil of dispersed clay. Some moisture is lost in runoff. The content of organic matter is low. Unprotected areas

are moderately susceptible to wind and water erosion. Yields are moderately low.

Suitable crops are grass-legume hay and native and tame grasses. A small grain generally is not suitable, but it may be grown with hay when the hay is reestablished. In areas where it is feasible, flood irrigation improves yields of hay and pasture.

CAPABILITY UNIT Vw-1

Only Gallatin soils, wet, are in this capability unit. They are loams and clay loams that have a high water table. The water table fluctuates between a few inches of the surface and 2½ feet.

These soils are fairly deep and have a high content of organic matter, but their water table keeps them from being suitable for cultivation. They occur along streams in small areas where drainage ordinarily is not feasible. These soils, however, abundantly produce water-tolerant grasses and sedges, which are grazed.

The chief management need is regulating grazing so that only about half of the current growth of desirable plants is used. Then the plants retain their vigor and produce some seed. For further information on range management refer to the subsection "Use and Management of Soils for Range." These soils are in the Wetland range site.

CAPABILITY UNIT VIe-1

This capability unit consists of black loams, clay loams, and channery clay loams that are 20 to 40 inches deep over shale, sandstone, or limestone on uplands and are more than 4 feet deep on fans. Slopes range from 8 to 35 percent. The soils are—

Alder-Maginnis complex, 8 to 35 percent slopes (Alder part).
Maginnis-Alder channery clay loams (Alder part).
Skaggs-Cheadle complex (Skaggs part).
Skaggs-Raynesford loams, 8 to 35 percent slopes.
Skaggs-Duncom-Hughesville complex (Skaggs part).

These soils have some qualities favorable for cultivation, but their steep slopes and other characteristics make them best suited to native range. The soils absorb water readily if the plant cover is good. They can store 4 to 6 inches of available moisture. Roots penetrate easily and deeply. On the other hand, these soils are on steep and moderately steep slopes, some of which are dissected by coulees, and they are intricately mixed with shallow or stony soils. The soils erode easily if they are not protected, but they are well suited to native grasses and other range plants. Yields are high under good management.

The chief management need is maintaining a good cover of desirable grasses. This can be partly done by regulating grazing so that not more than half of the current growth of desirable plants is grazed. Under this regulation and other good management, desirable grasses remain in the cover, and they may become dominant.

Most of the acreage of these soils has been left in native grasses, which is their best use. A few small areas are included in cultivated fields on more gentle slopes so that the fields can be more regular in shape. Native grasses are better suited to reseeding than introduced grasses. Sites suitable for farm ponds are available. These soils are in the Silty range site, 20 to 24 inches precipitation.

CAPABILITY UNIT VIe-2

This capability unit consists of black, granular clays that are 18 to 40 inches deep over clay shale on rolling uplands where most slopes range from 15 to 35 percent. The soils are—

Castle clay, 15 to 35 percent slopes.
Castle complex.

These soils are high in organic-matter content, and they retain their plant nutrients well. They have good moisture-storage capacity, but they absorb water slowly because they consist of clay. Root penetration is more difficult in these soils than in lighter textured ones. Also, roots are damaged by the expansion and contraction caused by wetting and drying.

Because slopes are steep and irregular, these soils are not suitable for cultivation. They are best suited to native grasses and produce well if they are carefully managed.

The chief management need is a good plant cover that is effective in controlling runoff and erosion. Regulated grazing, besides maintaining a protective cover, permits the more desirable, higher producing grasses to remain in the cover, and even to become the dominant vegetation.

By permitting only half of the current growth of the desirable grasses to be grazed and by other good management, the vigor of plants is retained and seed is produced. Sites for farm ponds are available on these soils. The soils of this capability unit are in the Clayey range site, 20 to 24 inches precipitation.

CAPABILITY UNIT VIe-3

This capability unit consists of dark to moderately dark colored clays and dark colored heavy clay loams. The clays are 15 to 30 inches deep over clay shale, and the clay loams are 2 to 3 feet deep over shale. These soils are steeply rolling and have slopes of 8 to 35 percent. They are—

Lismas-Pierre clays (Pierre part).
Pierre clay, 8 to 35 percent slopes.
Winifred-Utica clay loams (Winifred part).

These soils absorb water at a slow or moderately slow rate, but if the plant cover is good, good use is made of moisture that falls as snow or rain. Runoff is rapid during intense rains, especially where plant cover has been depleted. These soils can store 4 to 5 inches of available moisture, but shallow-rooted plants do not send their roots deep enough to obtain the moisture they need. Because slopes are steep and irregular and are dissected by coulees, these soils are not suitable for cultivation. They are best used for native grasses. Under good management, good to fair yields of forage are produced.

A good plant cover reduces runoff and controls erosion. Only half of the current growth of the desirable grasses should be grazed. Then plants retain their vigor and produce seed that replenishes the stand of desirable grasses.

Native grasses are best for reseeding range on these soils. Sites are available for farm ponds and for wildlife areas.

CAPABILITY UNIT VIe-4

This capability unit consists of dark-colored light clay loams that are 20 to 40 inches deep over shale on hilly uplands and foot slopes. Some of the soils are channery. The soils in this unit are—

Darret-Cheadle complex, 8 to 35 percent slopes (Darret part).
Maginnis-Absarokee channery clay loams (Absarokee part).

These soils absorb water readily if they have a good plant cover. They can store 3 to 5 inches of available

moisture. They have a moderate supply of organic matter and retain plant nutrients well. Roots penetrate these soils easily.

Because these soils occur in narrow, irregularly shaped areas on strong or steep slopes, some of which are dissected with coulees, they are not suitable for cultivation. Unprotected areas erode easily. Native range is the best use and produces good to fair yields under good management.

The chief need is maintaining a good composition of desirable plants. A good plant cover lessens runoff and erosion. Grazing should be regulated so that only half of the current growth of desirable grasses is used. The remaining half protects the soils and enables seed to be produced. Where reseeding is necessary, use native grasses. Sites for farm ponds are available. These soils are in the Silty range site, 15 to 19 inches precipitation.

CAPABILITY UNIT VIe-5

This capability unit consists of shallow, dark-colored, channery, loamy soils that are 5 to 12 inches deep over hard shale and sandstone and occur on steep and moderately steep slopes of rolling and hilly uplands. The soils are—

Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded (Cheadle part).
Alder-Maginnis complex, 8 to 35 percent slopes (Maginnis part).
Maginnis-Absarokee channery clay loams (Maginnis part).
Maginnis-Alder channery clay loams (Maginnis part).
Teton-Cheadle channery loams, 4 to 15 percent slopes (Cheadle part).

These soils have low moisture-storage capacity. Much of the rain runs off, and some of the snow blows off. The surface layer is thin, and the organic-matter content is low. Roots penetrate into the fine material between the weathered fragments of rock.

Because these soils are steep and shallow or very shallow, they are not suitable for cultivation. Their best use is for range, but yields of forage are low.

The chief management need is maintaining a desirable composition of good forage plants. Because of the steep slopes, reseeding is difficult but can be done in most places. Native grasses grow best.

CAPABILITY UNIT VIe-6

This capability unit consists of strongly sloping to steep soils that have a thin surface layer. These soils are underlain by clay loam shale or by pebbles mixed with material finer than sand. The soils are—

Chama-Midway clay loams, 8 to 15 percent slopes (Midway part).
Cheadle-Big Timber-Rock outcrop complex (Big Timber part).
Cheadle channery loam, 8 to 15 percent slopes.
Darret-Utica complex.
Judith-Utica gravelly loams, 8 to 15 percent slopes (Utica part).
Maginnis cobbly clay loam.
Midway clay loam.
Midway-Shale outcrop complex (Midway part).
Utica gravelly loam, 8 to 35 percent slopes.
Winifred-Utica clay loams (Utica part).

These soils are low in organic-matter content. Because slopes are strong or steep, much rainwater runs off. Also, much snow blows off the west-facing slopes. Because so much moisture is lost and because the amount of soil material is small, these soils are droughty and are not suitable for cultivation. They are suitable for grazing, but only low yields of forage can be expected.

Although the native plant cover is sparse in places, it is effective in reducing runoff and controlling erosion. Good management in which only half of the current growth of desirable grasses is grazed permits the plants to retain their vigor and produce enough seed to replenish the stands. Native grasses are best for reseeding.

CAPABILITY UNIT VIe-7

This capability unit consists of loams and clay loams that are more than 20 inches deep over sandstone, limestone, shale, or igneous rock. These soils are wooded and occur in mountainous areas, mainly on slopes of 8 to 25 percent. They are—

Hughesville-Duncom complex (Hughesville part).
Loberg stony loam.
Loberg-Sapphire complex.
Sapphire soils.
Sapphire-Cheadle complex (Sapphire part).
Skaggs-Duncom-Hughesville complex (Hughesville part).
Woodhurst-Loberg complex (Loberg part).

In places where the native trees remain, these soils take in water readily and have good to fair moisture-storage capacity. They can hold about 4 inches of available moisture in the top 2 feet of soil and variable amounts below. The tree roots penetrate into the sandstone and shale material to some extent and take in moisture that has penetrated into the bedrock.

In places where trees remain, these soils do not erode. The cover, including forest litter, helps the soils to act as a reservoir that regulates the release of melted snow and rainwater to streams. It also helps take in water that replenishes the underground supply. Where the cover has been destroyed, however, these soils are susceptible to erosion and flooding.

The chief management need is maintaining the native cover. Good woodland management, including protection from fire, diseases, and insects, is most important.

CAPABILITY UNIT VIe-8

In this capability unit are soils that have a thin surface layer and a claypan and soils that consist of dispersed clay. Slopes range from 2 to 15 percent. The soils are—

Arvada-Terrad clays.
Clayey alluvial land.

Because of the clay or dispersed clay these soils take in water slowly or very slowly. Much water is lost through runoff from the more sloping areas. The organic-matter content is low. Roots cannot penetrate deeply.

Grazing is the best use, but only small to moderately small yields of forage can be produced.

The chief management need is maintaining a desirable composition of good forage plants. If only half of the current growth of the desirable vegetation is grazed, the plants retain their vigor, produce seed, and help to reduce runoff and erosion.

Native grasses are best for reseeding range. For further information on range management refer to the subsection "Use and Management of Soils for Range." These soils are in the Dense Clay range site.

CAPABILITY UNIT VIw-1

This capability unit consists of deep clays and loamy soils that are poorly drained, subject to flooding, or both.

These soils occur in ponded areas and in narrow bottoms where stream channels meander from one side to the other. Small areas of well-drained soils occur at the outer edges of the narrow bottoms. The soils in this unit are—

Dimmick clay.
Gallatin and Raynesford loams.
Wet land.

The amount of overflow in the ponded areas varies with the seasons and from one area to another. In some places where water stands part of the time, there is little or no vegetation, but generally water-tolerant grasses and sedges grow well in ponded areas and in the flooded bottoms.

Because these soils are wet, flooded, and dissected by streams, they are not suitable for cultivation. They are best suited to grazing, but the grazing should be regulated so that not more than half of the current growth is grazed. Then the plants retain their vigor and produce seed.

In some years hay can be cut in the ponded areas and in the higher lying area at outer edges of the flooded bottoms. Sites are available for farm ponds and for wildlife areas. This capability unit is in the Subirrigated range site.

CAPABILITY UNIT VIs–1

This capability unit consists of deep and moderately deep, black stony loams and stony clay loams on uplands and fans that have slopes mainly ranging from 4 to 15 percent. The soils are—

Alder stony clay loam, 8 to 15 percent slopes.
Bridger stony loam.
Duncom-Skaggs-Rock outcrop complex (Skaggs part).
Judith and Raynesford stony loams, 2 to 8 percent slopes.
Judith and Raynesford stony loams, 8 to 15 percent slopes.
Little Horn stony loam.
Raynesford and Adel stony loams, 4 to 15 percent slopes.
Skaggs stony clay loam.
Skaggs-Duncom stony clay loams (Skaggs part).
Teton-Adel stony loams.
Teton-Cheadle stony loams, 4 to 15 percent slopes (Teton part).
Teton-Cheadle stony loams, 15 to 35 percent slopes (Teton part).
Woodhurst-Teton-Cheadle soils (Teton part).

Where the plant cover is good, these soils absorb water readily. They average about 30 inches in depth to rock or very coarse materials and can store about 4 inches of available moisture. They are generally not suited as cropland, because they are stony, but the growth of native grasses and other range plants is good.

The chief management need is maintaining a desirable composition of good range plants. If a good plant cover is maintained, there is little or no erosion hazard. Stones on the surface make reseeding more difficult and costly than on nonstony soils, but these soils can be reseeded if the plant cover is destroyed. Native grasses should be used for reseeding. Sites are available for farm ponds and wildlife areas. Most of these soils are in the Silty range site, 20 to 24 inches precipitation.

CAPABILITY UNIT VIs–2

This capability unit consists of moderately deep, dark-colored stony loams and stony clay loams on uplands and benches. The average depth of these soils is 24 inches. Slopes range from 2 to 15 percent. The soils are—

Absarokee-Cheadle stony loams (Absarokee part).
Blaine-Spring Creek stony loams (Blaine part).
Danvers stony clay loam, 2 to 4 percent slopes.
Darret stony clay loam.
Spring Creek-Blaine stony loams (Blaine part).
Utica-Judith stony loams.

If the plant cover is good, these soils take in water readily. They can store 3 to 4 inches of available moisture.

Because they are stony, these soils are not suited as cropland, but they support a good growth of grasses and other range plants.

The chief management need on these soils is maintaining a desirable composition of range plants. If a good plant cover is maintained, there is little or no erosion hazard. Stones on the surface make reseeding difficult and more costly than on nonstony soils, but these soils can be reseeded if the plant cover is destroyed. Native grasses are needed for reseeding. The soils in this unit are in the Silty range site, 15 to 19 inches precipitation.

CAPABILITY UNIT VIs–3

In this capability unit are gravelly loams that are underlain by cemented pebbles of limestone at a depth of 4 to 20 inches. These soils occur on nearly level to gently sloping benches. They are—

Ashuelot gravelly loam.
Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Ashuelot part).

These Ashuelot soils are droughty because they are shallow and contain much gravel. In some places where they are intermingled with Judith soils, they are cultivated, but separate areas of the Ashuelot soils are suitable only for grazing, and they produce moderately small amounts of forage. Native grasses should be used for reseeding the range. For further information on management refer to the subsection "Use and Management of Soils for Range." The soils in this unit are in the Shallow range site.

CAPABILITY UNIT VIs–4

This capability unit consists of poorly drained, saline soils in upland swales, on slopes, in narrow strips along drainageways, and in a few broader areas on terraces. These soils are—

Arvada-Beckton complex, saline.
Loamy alluvial land.
Saline land.

Because these soils have a high water table and a high salt content, they are not suitable for cultivation. Where tillage is possible, it only worsens drainage and salinity. These soils are best suited for grazing and for producing small amounts of hay.

Good conservation on the higher lying, adjoining uplands lessens the amount of runoff that flows onto these soils and the amounts of water and salts that concentrate. If grazing is regulated so that only half of the current growth of desirable plants is used, the remaining plants retain their vigor and produce seed. The more vigorous the growth of water- and salt-tolerant plants, the more excess salt and water are taken from the soil. In this way the water and salt problem is kept in check by the vigorous growth of native plants. These soils are in the Saline Subirrigated range site.

CAPABILITY UNIT VIIs–1

In this capability unit are black stony loams that are in mountainous areas and are more than 20 inches deep over igneous rock or sandstone. Slopes range from 8 to 50 percent. The soils are—

Woodhurst stony loam.
Woodhurst-Alder stony complex.
Woodhurst-Loberg complex (Woodhurst part).
Woodhurst-Spring Creek stony complex (Woodhurst part).
Woodhurst-Teton-Cheadle soils (Woodhurst part).

These soils take in water readily and are well supplied with organic matter. Because they contain many stones, the soils can store only 3 to 4 inches of available moisture. They are too stony for cultivation but support a good growth of grasses and other range plants.

If grazing is regulated so that only half the current growth of desirable plants is grazed, the remaining plants retain their vigor and produce seed. Reseeding is very difficult on these stony soils. The soils in this unit are in the Silty range site, 20 to 24 inches precipitation.

CAPABILITY UNIT VIIs-2

This capability unit consists of dark-colored stony loams and other stony soils that are underlain by sandstone, limestone, or igneous rock at a depth of 8 to 18 inches. These soils are on slopes that range generally from 8 to 35 percent, and they are generally closely intermingled with deeper soils. The soils are—

Absarokee-Cheadle stony loams (Cheadle part).
Blaine-Spring Creek stony loams (Spring Creek part).
Cheadle-Big Timber-Rock outcrop complex (Cheadle part).
Cheadle stony loam.
Cheadle-Rock outcrop complex (Cheadle part).
Cheadle-Duncom-Rock outcrop complex (Cheadle and Duncom parts).
Darret-Cheadle complex, 8 to 35 percent slopes (Cheadle part).
Duncom stony loam.
Duncom-Rock outcrop complex (Duncom part).
Duncom-Skaggs-Rock outcrop complex (Duncom part).
Hughesville-Duncom complex (Duncom part).
Sapphire-Cheadle complex (Cheadle part).
Skaggs-Cheadle complex (Cheadle part).
Skaggs-Duncom stony clay loams (Duncom part).
Skaggs-Duncom-Hughesville complex (Duncom part).
Spring Creek-Blaine stony loams (Spring Creek part).
Teton-Cheadle stony loams, 4 to 15 percent slopes (Cheadle part).
Teton-Cheadle stony loams, 15 to 35 percent slopes (Cheadle part).
Woodhurst-Spring Creek stony complex (Spring Creek part).
Woodhurst-Teton-Cheadle soils (Cheadle part).

These soils take in water readily, but they are shallow and have low moisture-storage capacity. Their surface soil is thin but contains an adequate supply of organic matter.

These soils are too stony, too steep, and too droughty for cultivation and are best suited to grazing, but they produce fairly low yields of forage.

If a good plant cover is maintained, erosion is not a problem. The chief management need is maintaining the proper plant composition by regulated grazing. Only half of the current growth of the desirable grasses should be grazed. For further information on range management refer to subsection "Use and Management of Soils for Range." Most of these soils are in the Shallow range site.

CAPABILITY UNIT VIIs-3

Cobbly alluvial land is the only soil in this capability unit. It consists of cobbly or gravelly soil material that has a thin, dark-colored surface layer underlain by loose sand, pebbles, and cobblestones. It occurs on narrow flood plains along some of the major drainageways.

The soil material takes in water rapidly and contains a fair amount of organic matter, but it is coarse textured and has very low moisture-storage capacity. It is too cobbly and too droughty for producing hay or small grains and is best used for grazing. The land is likely to be flooded, but erosion is not a problem. Yields of forage are low, even under the best management.

The chief management need is maintaining the proper composition of grasses. Only half of the current growth of the desirable grasses should be grazed. Then the remaining plants retain their vigor and produce some seed. These soils are in the Shallow to Gravel range site.

CAPABILITY UNIT VIIs-4

This capability unit consists of clays underlain by clay shale at a depth of 4 to 12 inches. These soils occur on rolling to hilly uplands that have slopes ranging from 8 to 35 percent. They are—

Lismas-Pierre clays (Lismas part).
Lismas-Shale outcrop complex (Lismas part).

These soils absorb water slowly. They can hold, on the average, about 2 inches of available moisture, but considerable water is lost through runoff. The organic-matter content is low. Roots do not penetrate the soils deeply.

Because these soils are generally steep and have other unfavorable characteristics, they are not suitable for cultivation. They are best suited to grazing, but yields of forage are moderately low.

A cover of the desirable grasses helps to lessen water erosion and to maintain the highest yields of forage. This cover can be obtained and maintained if management is good for a long time and includes grazing only half of the current growth of the desirable grasses. For further information on range management refer to the subsection "Use and Management of Soils for Range." The soils in this unit are in the Shallow Clay and the Shale range sites.

CAPABILITY UNIT VIIs-5

Only Arvada-Laurel complex (Laurel part) is in this capability unit. It consists of a nearly barren, dispersed, strongly saline soil that occurs on fans and terraces, where it is intermingled with soils that have a thin surface layer and a claypan.

This soil takes in water very slowly because the soil material is dispersed clay. It tends to seal when it is wet. This sealing and the high content of salts prevent the few roots in this soil from penetrating deeply. Because the soil has so little plant growth, there is practically no organic matter. For these reasons, this soil is not suitable for cultivation. It produces only a very sparse growth of a few grasses and other range plants.

The same principles of range management apply to this soil that apply to soils having better plant cover. The plant composition of the closely associated soils may serve as a guide in regulating the grazing for both soils. Only half of the current growth of desirable plants should be grazed. For further information on range management refer to the subsection "Use and Management of Soils for Range." The soil in this capability unit is in the Panspots range site.

CAPABILITY UNIT VIIs-6

This capability unit consists of light-colored, stony, loamy soils that occur on steep, wooded mountainous

slopes and are 12 to 36 inches deep over rock. The soils are—

Cowood stony loam.
Cowood-Rock outcrop complex (Cowood part).

These soils take in water readily, but they contain much gravel, are shallow, and have low moisture-storage capacity. Tree roots, however, penetrate to some extent into the weathered rock and obtain some moisture from it.

These soils are too steep and too stony for cultivation. Where the trees remain, the soils do not erode. The cover helps them take in water that replenishes the underground supply, and that helps regulate the flow of water in streams. The chief management need is maintaining a good cover that protects the soils from water erosion. Also, protection from fire, diseases, and insects is needed.

CAPABILITY UNIT VIIIs-1

This capability unit consists of outcrops of barren shale, sandstone, limestone, and igneous rock that occur closely with soils. These outcrops are in rough areas. They are—

Cheadle-Big Timber-Rock outcrop complex (Rock outcrop part).
Cheadle-Rock outcrop complex (Rock outcrop part).
Cheadle-Duncom-Rock outcrop complex (Rock outcrop part).
Cowood-Rock outcrop complex (Rock outcrop part).
Duncom-Rock outcrop complex (Rock outcrop part).
Duncom-Skaggs-Rock outcrop complex (Rock outcrop part).
Lismas-Shale outcrop complex (Shale outcrop part).
Midway-Shale outcrop complex (Shale outcrop part).

These outcrops, for the most part, are barren areas. In a few spots the soil material is deep enough to produce a sparse growth of grasses and trees. The outcrops have no value except as water-producing areas.

Predicted yields of dryland crops

The yields that a farmer or rancher obtains from any soil depend on the characteristics of the soil itself, the weather, diseases and insects, and soil management. Important characteristics that affect crop yields are depth to which moisture is stored, content of organic matter, and natural fertility. The weather is important, but man has little control over it. Damage from insects and diseases can be lessened by appropriate management. In fact, through management farmers and ranchers can do many things that offset the adverse factors of soils and weather and thereby insure good yields.

If several practices are used to increase yields, these practices have a cumulative effect. For example, practices to control weeds may increase yields of some crops 2 bushels per acre, and timely tillage may increase them another 4 or 5 bushels. An additional 2 bushels may be added by farming on the contour and stubble mulching. These combined practices, therefore, give a total increase of 8 or 9 bushels per acre.

Best yields are obtained by—

1. Timely tilling and seeding.
2. Using sweeps to keep crop residues at the surface.
3. Seeding the best of the adapted varieties.
4. Controlling weeds.
5. Adding fertilizer if the soil is deep enough and has adequate moisture.
6. Farming slopes on the contour so that runoff and loss of soil are reduced.
7. Reestablishing hay stands when they begin to get thin, perhaps every 5 to 7 years; seed these after a short period of grain and fallow.
8. Growing grasses and legumes together rather than separately so that yields are improved.

Table 2 lists, for the soils in the survey area suited to crops, the predicted yields of the principal dryland crops grown under two levels of management. Soils and land types not suited to crops are not listed. In columns A are average yields that may be obtained by using the prevailing management. Columns B list yields that may be obtained if the best known management is applied.

These predictions are based on a study of the records kept by farmers and ranchers and by the branch of the Montana Agricultural Experiment Station at Moccasin. The predicted yields from soils on which no records have been kept were obtained by talking to farmers, by observing these soils, and by comparing them to soils on which records are available.

Use and Management of Soils for Irrigated Crops [2]

After a few statements about irrigated soils in the survey area and their use, this subsection briefly describes the capability classes, subclasses, and units for irrigated crops. Then the irrigated soils are placed in capability units, and the use and management of these units are discussed.

Only about 8,000 acres of land in the survey area are irrigated at the present time. Soils under irrigation are mostly in scattered fields that make up only a small part of some operating units. These fields are used mainly for permanent hay or pasture. Stands are destroyed only after they have declined in productivity, at which time a small grain is grown for 1 or 2 years, and then hay or pasture is reseeded.

For best production, alfalfa needs to be replanted after it has been cut for 5 to 7 years. Phosphate fertilizer has not been used extensively, but its use can be expected to increase because soil tests are beginning to show a need for phosphorus.

In this area only two crops of alfalfa can be expected. Harvesting a short third crop is detrimental to the stand and reduces the yields in the succeeding year. Fall, winter, or spring grazing may also contribute to deterioration of the stand and lower production.

Irrigated pastures need nitrogen fertilizer and a small application of phosphate. To maintain good stands of vigorous plants, irrigated pastures need to be reestablished after 8 to 10 years.

Where feasible, irrigated fields are leveled to provide better use of water and to save time in irrigating.

CAPABILITY GROUPS OF IRRIGATED SOILS

Forty-one mapping units in the survey area have been grouped so that their use under irrigation can be discussed. The following outline briefly describes the capability classes, subclasses, and units in which these irrigated soils have been placed.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.

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[2] By WENDELL THACKER, agronomist, Soil Conservation Service.

TABLE 2.—*Predicted average acre yields of principal dryland crops under prevailing and improved management*

[In columns A are yields under prevaling management; in columns B are yields that could be obtained under improved management. Absence of yield indicates soil is not suited to the crop. If a soil is not listed in this table, it is considered not suitable for dryland crops]

Map symbol	Soil	Winter wheat		Spring wheat		Barley		Oats		Hay											
										Alfalfa		Crested wheat		Crested wheat-alfalfa		Intermediate wheat-grass		Intermediate wheat-grass-alfalfa		Brome-grass-alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Aa	Absarokee clay loam, 2 to 8 percent slopes	22	28	16	20.	28	35	35	45	0. 4	0. 8	0. 5	1. 0	0. 8	1. 5	0. 5	0. 8	0. 8	1. 5	----	----
Ab	Absarokee clay loam, 8 to 15 percent slopes	15	20	12	15	25	30	30	40	. 4	. 8	. 4	. 8	. 6	1. 2	. 4	. 8	. 6	1. 2	----	----
Ac	Absarokee silty clay, 2 to 8 percent slopes	22	28	16	20	28	35	36	45	. 4	. 8	. 5	1. 0	. 8	1. 5	. 5	. 8	. 8	1. 5	----	----
Ad	Absarokee-Cheadle channery loams, 2 to 8 percent slopes	18	22	15	18	22	30	32	42	. 2	. 6	. 2	. 7	. 5	1. 0	. 2	. 7	. 5	1. 0	----	----
Af	Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded	12	16	10	14	20	25	25	30	. 2	. 6	. 2	. 6	. 5	1. 0	. 2	. 6	. 5	1. 0	----	----
Ah	Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes	12	16	10	14	22	26	28	35	. 3	. 6	. 2	. 7	. 5	1. 0	. 2	. 7	. 5	1. 0	----	----
Ak	Adel loam, 2 to 8 percent slopes	32	42	25	28	35	50	45	60	1. 0	1. 5	----	----	----	----	----	----	----	----	1. 5	2. 5
Al	Adel loam, 8 to 18 percent slopes	26	34	18	22	30	40	40	55	. 8	1. 2	----	----	----	----	----	----	----	----	1. 5	2. 5
Am	Adel silt loam, terrace	32	42	25	28	35	45	45	60	. 8	1. 5	----	----	----	----	1. 2	2. 0	1. 5	2. 5	1. 5	2. 5
An	Alder clay loam, 2 to 8 percent slopes	28	38	25	28	35	50	45	60	. 8	1. 2	----	----	----	----	1. 2	2. 0	1. 5	2. 5	1. 5	2. 5
Ao	Alder clay loam, 8 to 15 percent slopes	25	30	20	23	30	40	40	50	. 5	1. 0	----	----	----	----	1. 0	1. 8	1. 0	2. 0	1. 0	2. 0
Ar	Alder-Maginnis channery clay loams, 2 to 8 percent slopes	15	20	12	15	25	30	30	38	. 6	1. 2	----	----	----	----	. 8	1. 5	1. 0	2. 0	1. 0	2. 0
At	Arvada-Beckton cobbly clay loams	8	12	7	10	15	20	20	25	. 2	. 4	. 2	. 7	. 5	1. 0	. 2	. 7	. 3	. 8	----	----
Ba	Bainville loam	12	16	10	14	20	25	25	30	. 3	. 6	. 3	. 7	. 5	1. 0	. 2	. 6	. 5	1. 0	----	----
Bb	Beckton loam	10	15	8	12	18	22	25	35	. 2	. 6	. 2	. 7	. 5	1. 0	. 4	. 8	. 5	1. 0	----	----
Bc	Beckton-Arvada clay loams	10	15	8	12	18	22	25	30	----	. 6	. 2	. 7	. 5	1. 0	. 4	. 8	. 5	1. 0	----	----
Bd	Beckton-Danvers clay loams	18	22	15	18	22	30	32	42	----	. 8	. 5	1. 0	. 7	1. 3	. 5	. 8	. 6	1. 2	----	----
Bf	Beckton-Savage complex	22	28	16	20	30	38	40	50	. 5	1. 0	.5	1. 0	. 7	1. 3	. 5	. 8	. 6	1. 2	----	----
Bg	Blaine-Spring Creek loams, 2 to 8 percent slopes	15	20	12	15	25	30	30	38	. 4	. 8	. 5	1. 0	. 7	1. 3	. 5	1. 0	. 7	1. 5	----	----
Bk	Blythe loam, 2 to 4 percent slopes	25	32	22	25	30	38	40	50	. 7	1. 2	----	----	----	----	. 8	1. 5	1. 2	2. 0	1. 5	2. 3
Bm	Blythe loam, 4 to 8 percent slopes	25	32	22	25	30	38	40	50	. 7	1. 2	----	----	----	----	. 8	1. 5	1. 2	2. 0	1. 5	2. 3
Bo	Bowdoin silty clay, low clay variant	26	34	18	22	34	42	40	50	----	----	----	----	----	----	----	----	----	----	1. 5	2. 5
Bp	Bridger loam, 2 to 4 percent slopes	26	34	----	----	34	42	42	55	1. 0	1. 5	----	----	----	----	----	----	1. 5	2. 5	1. 5	2. 5
Br	Bridger loam, 4 to 15 percent slopes	22	28	----	----	28	35	35	45	. 8	1. 2	----	----	----	----	----	----	1. 2	2. 2	1. 2	2. 2
Ca	Castle clay, 4 to 15 percent slopes	20	25	----	----	25	32	32	42	. 7	1. 2	----	----	----	----	----	1. 2	1. 0	2. 0	1. 2	2. 2
Cd	Chama clay loam, 4 to 8 percent slopes	22	28	16	20	28	35	35	45	----	1. 0	. 5	1. 0	1. 0	1. 5	. 2	. 8	. 6	1. 5	----	----
Cf	Chama-Midway clay loams, 4 to 8 percent slopes	18	22	15	18	22	30	32	42	----	. 8	----	. 7	. 7	1. 0	. 2	. 7	. 5	1. 0	----	----
Cg	Chama-Midway clay loams, 8 to 15 percent slopes	12	16	10	14	18	22	25	30	----	. 5	. 3	. 7	. 5	1. 0	. 2	. 6	. 4	1. 0	----	----

TABLE 2.—*Predicted average acre yields of principal dryland crops under prevailing and improved management*—Continued

Map symbol	Soil	Winter wheat		Spring wheat		Barley		Oats		Hay											
										Alfalfa		Crested wheat		Crested wheat-alfalfa		Intermediate wheatgrass		Intermediate wheatgrass-alfalfa		Bromegrass-alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Ck	Cheadle channery loam, 2 to 8 percent slopes	8	12	7	10	15	20	20	25	0.2	0.5	0.3	0.7	0.5	1.0	0.2	0.6	0.3	0.8	----	----
Cn	Cheadle loam, 2 to 8 percent slopes	15	20	12	15	20	28	30	35	.3	.8	.5	1.0	.7	1.2	.5	1.0	.7	1.2	----	----
Co	Cheadle loam, 8 to 15 percent slopes	12	16	10	14	18	22	25	30	.2	.5	.2	.7	.5	1.0	.2	.6	.5	1.0	----	----
Cv	Colvin-Lamoure clay loams	22	28	16	20	----	----	35	45	----	----	----	----	----	----	----	----	----	----	1.5	2.5
Da	Danvers clay loam, 0 to 2 percent slopes	26	34	18	22	34	42	42	55	.8	1.2	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----
Db	Danvers clay loam, 2 to 4 percent slopes	26	34	18	22	34	42	42	55	.8	1.2	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----
Dc	Danvers clay loam, 4 to 8 percent slopes	22	28	16	20	30	38	40	50	.5	1.0	.7	1.0	.8	1.6	.5	.8	.8	1.6	----	----
Dd	Danvers cobbly clay loam, 0 to 4 percent slopes	22	28	16	20	30	38	40	50	.5	1.0	.5	1.0	.8	1.6	.5	.8	.8	1.6	----	----
Df	Danvers cobbly clay loam, 4 to 8 percent slopes	20	25	15	18	25	32	35	45	.5	1.0	.5	1.0	.8	1.6	.5	.8	.8	1.6	----	----
Dg	Danvers cobbly clay loam, 8 to 15 percent slopes	18	22	15	18	22	30	32	42	.2	.5	.2	.7	.5	1.0	.2	.7	.5	1.0	----	----
Dh	Danvers gravelly clay loam, 0 to 4 percent slopes	26	34	18	22	34	42	42	55	.5	1.0	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----
Dm	Danvers-Judith clay loams, 0 to 2 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Dn	Danvers-Judith clay loams, 2 to 4 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Do	Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Dp	Danvers-Judith gravelly clay loams, 0 to 2 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Dr	Darret clay loam, 8 to 15 percent slopes	18	22	15	18	22	30	32	42	.5	.8	----	----	----	----	.5	1.0	.8	1.5	----	----
Dt	Darret-Cheadle complex, 2 to 8 percent slopes	8	12	7	10	15	20	20	25	.2	.5	.3	.7	.5	1.0	.2	.6	.3	.8	----	----
Fa	Fargo-Hegne silty clays	15	20	12	15	----	----	----	----	----	----	----	----	----	----	.5	1.0	----	----	----	----
Fc	Fergus clay loam, 0 to 2 percent slopes	26	34	18	22	34	42	42	55	.8	1.5	----	----	----	----	.8	1.5	1.5	2.5	1.5	2.2
Fd	Fergus clay loam, 2 to 4 percent slopes	26	34	18	22	34	42	42	55	.6	1.2	----	----	----	----	.8	1.5	1.5	2.5	1.5	2.2
Ff	Fergus clay loam, 4 to 8 percent slopes	22	28	16	20	38	35	35	45	.6	1.2	----	----	----	----	----	1.0	1.0	1.5	----	----
Fh	Fergus clay loam, 8 to 15 percent slopes	18	22	15	18	22	30	32	40	.5	1.0	----	----	----	----	.5	.8	.8	1.2	----	----
Fs	Fergus silty clay loam, shale substratum, 2 to 8 percent slopes	26	34	18	22	34	42	42	55	.6	1.2	----	----	----	----	.8	1.5	1.5	2.5	----	----
Ga	Gallatin clay loam [1]	26	34	18	22	----	----	55	65	----	----	----	----	----	----	----	----	----	----	1.8	3.5
Gb	Gallatin loam [1]	26	34	18	22	----	----	55	65	----	----	----	----	----	----	----	----	----	----	1.8	3.5
Gc	Gallatin loam, clay substratum	26	34	18	22	----	----	45	60	----	----	----	----	----	----	----	----	----	----	1.5	3.0
Ja	Judith-Ashuelot gravelly loams, 0 to 4 percent slopes	8	12	7	10	15	20	20	25	----	.4	.2	.6	.4	.8	.2	.6	.4	.8	----	----

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal dryland crops under prevailing and improved management*—Continued

Map symbol	Soil	Winter wheat		Spring wheat		Barley		Oats		Hay											
										Alfalfa		Crested wheat		Crested wheat-alfalfa		Intermediate wheat-grass		Intermediate wheat-grass-alfalfa		Bromegrass-alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Jb	Judith clay loam, 0 to 2 percent slopes	22	28	16	20	28	35	35	45	0.4	0.8	0.5	1.0	0.7	1.3	0.5	0.8	0.6	1.2	----	----
Jc	Judith clay loam, 2 to 4 percent slopes	22	28	16	20	28	35	35	45	.4	.8	.5	1.0	.7	1.3	.5	.8	.6	1.2	----	----
Jd	Judith clay loam, 4 to 8 percent slopes	18	22	15	18	22	30	32	42	.2	.6	.3	.8	.6	1.0	.3	.7	.5	1.0	----	----
Jf	Judith clay loam, low terrace	18	22	15	18	22	30	32	42	.2	.6	.3	.8	.6	1.0	.3	.7	.5	1.0	----	----
Jh	Judith cobbly clay loam, 0 to 4 percent slopes	15	20	12	15	20	28	30	40	.2	.6	[2].3	[2].8	.5	1.0	.2	.7	.5	1.0	[3].8	[2]1.2
Jk	Judith cobbly clay loam, low terrace, 0 to 4 percent slopes	15	20	12	15	20	28	30	40	.2	.6	.3	.8	.5	1.0	.2	.7	.5	1.0	----	----
Jl	Judith gravelly clay loam, 0 to 2 percent slopes	18	22	15	18	22	30	32	42	.2	.6	.3	.8	.5	1.0	.2	.7	.5	1.0	----	----
Jm	Judith gravelly clay loam, 2 to 4 percent slopes	18	22	15	18	22	30	32	42	.2	.6	[2].3	[2].8	.5	1.0	.2	.7	.5	1.0	[3].8	[2]1.2
Jn	Judith gravelly clay loam, 4 to 8 percent slopes	15	20	12	15	20	28	30	40	.2	.6	[2].3	[2].8	.5	1.0	.2	.7	.5	1.0	[3].8	[2]1.2
Jo	Judith gravelly clay loam, low terrace, 0 to 4 percent slopes	15	20	12	15	20	28	30	40	.2	.6	.3	.8	.5	1.0	.2	.7	.5	1.0	----	----
Jp	Judith-Danvers gravelly clay loams, 0 to 4 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Jt	Judith and Savage soils	15	20	12	15	26	32	30	40	.2	.6	.2	.7	.5	1.0	.2	.7	.5	1.0	----	----
Ju	Judith-Utica gravelly loams, 4 to 8 percent slopes	15	20	12	15	20	28	30	40	.2	.5	.3	.8	.5	1.0	.2	.7	.5	1.0	----	----
Jv	Judith-Utica gravelly loams, 8 to 15 percent slopes	10	15	8	12	18	22	25	30	.2	.4	.2	.6	.4	.8	.2	.6	.4	.8	----	----
Pc	Pierre clay, 2 to 8 percent slopes	10	15	8	12	18	22	25	30	.4	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Pm	Promise clay, 0 to 2 percent slopes	22	28	16	20	28	35	35	45	.5	1.0	.5	1.0	1.0	1.8	.8	1.0	1.0	1.8	----	----
Po	Promise clay, 2 to 8 percent slopes	22	28	16	20	28	35	35	45	.7	1.0	.5	1.0	.8	1.5	.5	1.0	.8	1.5	----	----
Pp	Promise clay, 8 to 15 percent slopes	20	25	15	18	25	30	30	35	.7	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Pr	Promise cobbly clay	20	25	15	18	25	30	30	35	.7	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Ra	Raynesford and Adel loams, 2 to 4 percent slopes	32	42	----	----	35	45	45	60	1.0	1.5	----	----	----	----	----	----	1.5	1.5	1.8	2.8
Rd	Raynesford and Adel loams, 4 to 8 percent slopes	32	42	----	----	35	50	45	60	1.0	1.5	----	----	----	----	.8	1.2	1.5	2.5	1.8	2.8
Rf	Raynesford and Adel loams, 8 to 15 percent slopes	26	34	----	----	30	40	40	55	1.0	1.2	----	----	----	----	.8	1.2	1.5	2.5	1.5	2.5
Ro	Rhodes-Arvada complex	8	12	7	10	15	20	20	25	.2	.4	.2	.7	.5	1.0	.2	.7	.4	.8	----	----
Sd	Savage silty clay, 0 to 2 percent slopes	26	34	18	22	34	42	42	55	.8	1.2	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----
Se	Savage silty clay, 2 to 4 percent slopes	26	34	18	22	34	42	42	55	.8	1.2	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----
Sf	Savage silty clay, 4 to 8 percent slopes	22	28	16	20	30	38	40	55	.5	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Sg	Savage silty clay loam, 0 to 2 percent slopes	26	34	18	22	34	42	42	55	.5	1.2	.8	1.2	1.0	1.8	.7	1.0	1.0	1.8	----	----

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal dryland crops under prevailing and improved management*—Continued

Map symbol	Soil	Winter wheat		Spring wheat		Barley		Oats		Hay											
										Alfalfa		Crested wheat		Crested wheat-alfalfa		Intermediate wheat-grass		Intermediate wheat-grass-alfalfa		Bromegrass-alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Sh	Savage silty clay loam, 2 to 4 percent slopes	26	34	18	22	34	42	42	55	0.5	1.2	0.8	1.2	1.0	1.8	0.7	1.0	1.0	1.8	----	----
Sk	Savage silty clay loam, 4 to 8 percent slopes	22	28	16	20	28	35	35	45	.4	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Sl	Skaggs loam	12	16	----	----	18	22	25	30	----	----	----	----	----	----	.8	1.0	.8	1.3	1.0	2.0
Sm	Skaggs clay loam, 4 to 8 percent slopes	25	30	----	----	30	38	40	50	.8	1.2	----	----	----	----	----	----	1.5	2.5	1.5	2.5
Sn	Skaggs clay loam, 8 to 15 percent slopes	15	20	----	----	25	30	30	38	.4	1.0	----	----	----	----	----	----	1.0	2.2	1.0	2.2
Su	Slocum loam	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.8	3.5
Sw	Straw clay loam, 0 to 2 percent slopes	22	28	16	20	28	35	35	45	.4	.8	.5	1.0	.7	1.3	.5	.8	.6	1.2	----	----
Sx	Straw clay loam, 2 to 4 percent slopes	22	28	16	20	28	35	35	45	.4	.8	.5	1.0	.7	1.3	.5	.8	.6	1.2	----	----
Sy	Straw clay loam, gravelly substratum	18	22	15	18	22	30	32	42	.2	.6	.3	.8	.6	1.0	.3	.7	.5	1.0	----	----
Ta	Terrad clay, 2 to 8 percent slopes	26	34	18	22	34	42	42	55	.5	1.2	----	----	----	----	.8	1.5	1.0	2.0	1.0	2.0
Tb	Terrad clay, 8 to 35 percent slopes	22	28	16	20	30	38	40	50	.4	1.0	----	----	----	----	.5	.8	.8	1.5	.8	1.5
Tc	Terrad silty clay, 0 to 2 percent slopes	26	34	18	22	34	42	42	55	1.0	1.5	----	----	----	----	.8	1.5	1.5	2.5	----	----
Td	Teton loam, 2 to 8 percent slopes	32	42	----	----	35	50	45	60	.8	1.2	----	----	----	----	.8	1.0	1.5	2.5	1.5	2.5
Tf	Teton loam, 8 to 15 percent slopes	26	34	----	----	34	42	42	55	.5	1.0	----	----	----	----	.5	.8	1.0	2.2	1.0	2.2
Tk	Teton-Cheadle channery loams, 4 to 15 percent slopes	22	28	----	----	28	35	35	45	.5	1.0	----	----	----	----	----	----	----	----	1.5	2.5
To	Twin Creek loam, 2 to 4 percent slopes	22	28	16	20	28	35	35	45	.5	1.0	----	----	----	----	.8	1.2	1.0	1.8	----	----
Tp	Twin Creek loam, 4 to 8 percent slopes	22	28	16	20	28	35	35	45	.4	.8	----	----	----	----	.5	1.0	.8	1.5	----	----
Tr	Twin Creek loam, 8 to 15 percent slopes	10	15	8	12	18	22	25	30	.2	.5	----	----	----	----	.2	.6	.5	1.0	----	----
Tw	Twin Creek clay loam, 0 to 2 percent slopes	22	28	16	20	28	35	35	45	.5	1.0	----	----	----	----	.8	1.2	1.0	1.8	----	----
Ua	Utica gravelly loam, 2 to 8 percent slopes	8	12	7	10	15	20	20	25	.2	.4	.2	.7	.5	1.0	.2	.7	.3	.8	----	----
Ug	Utica-Judith gravelly loams, sandy substratum	8	12	7	10	15	20	20	25	.2	.4	.2	.7	.5	1.0	----	----	----	----	----	----
Wb	Winifred clay loam, 0 to 4 percent slopes	28	36	25	28	38	45	45	55	.8	1.0	.8	1.2	1.0	1.8	.7	.1	1.0	1.8	----	----
Wc	Winifred clay loam, 4 to 8 percent slopes	28	36	25	28	38	45	45	55	.8	1.0	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Wd	Winifred clay loam, 8 to 15 percent slopes	22	28	16	20	30	38	40	50	.4	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Wf	Winifred cobbly clay loam, 2 to 8 percent slopes	22	28	16	20	30	38	40	50	.4	.8	.5	1.0	.8	1.5	.5	.8	.8	1.5	----	----
Wh	Winifred cobbly clay loam, 8 to 15 percent slopes	18	22	15	18	22	30	32	42	.4	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Wk	Winifred-Judith clay loams	18	22	15	18	22	30	32	42	.4	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----
Wm	Winifred-Rhoades clay loams	20	25	15	18	25	30	30	35	.4	.8	.2	.8	.5	1.0	.2	.6	.5	1.0	----	----

[1] This soil is also listed in the table for principal irrigated crops (table 3) because it is in capability unit IIw–1, irrigated and nonirrigated.

[2] Crested wheatgrass hay is better suited in the black soil area of high rainfall.

[3] Bromegrass-alfalfa hay is better suited in the places not in the black soil area of high rainfall.

Capability unit IIs–1, irrigated.—Moderately deep, dark-colored clay loams over gravel on nearly level slopes.
Capability unit IIs–2, irrigated.—Deep, dark-colored silty clays on nearly level slopes.
Capability unit IIs–3, irrigated.—Deep, dark-colored, nearly level gravelly clay loams underlain by pebbles mixed with material finer than sand at a depth of 15 to 30 inches.

Subclass IIc. Soils that have moderate limitations because of climate.
Capability unit IIc–3, irrigated.—Deep, dark-colored clay loams and silty clay loams on nearly level slopes.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
Capability unit IIIe–6, irrigated.—Deep, black, loamy soils on gentle slopes.
Capability unit IIIe–7, irrigated.—Deep, dark-colored, loamy soils on gentle slopes.
Capability unit IIIe–8, irrigated.—Deep, dark-colored silty clays on gentle slopes.
Capability unit IIIe–9, irrigated.—Deep, dark-colored cobbly and gravelly clay loams on nearly level to gentle slopes.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
Capability unit IVe–6, irrigated.—Deep, black loams on moderate to moderately steep slopes.
Capability unit IVe–7, irrigated.—Deep, dark-colored, loamy soils on moderate to moderately steep slopes.
Capability unit IVe–8, irrigated.—Deep, dark-colored, granular, clayey soils on moderate slopes.
Capability unit IVe–9, irrigated.—Deep, cobbly and gravelly clay loams on moderate to moderately steep slopes.

Management of irrigated soils by capability units

In this subsection, each capability unit is described and the soils in the unit are listed. The rate of water intake, depth for storing moisture, hazard of erosion, and other limitations are briefly discussed. Some of the crops suited to each group are mentioned.

The water intake given for each capability unit is the basic intake rate. This rate has been called the saturated intake rate to make the term somewhat self-explanatory. When water is applied to a dry soil, it first enters the soil at a rapid rate and then gradually enters more slowly as more and more water is taken in. Eventually the rate is almost constant. This is the basic intake rate.

CAPABILITY UNIT IIs–1, IRRIGATED

This capability unit consists of dark-colored clay loams that are underlain by gravel at a depth of 18 to 30 inches. The soils are nearly level. They are—

Judith clay loam, low terrace.
Straw clay loam, gravelly substratum.

These soils take in water at the moderate saturated intake rate of about 1½ inches per hour. They can hold about 2 inches of available moisture per foot of soil. Above the gravel, therefore, they can hold an average total of about 4 inches. The natural fertility of these soils is moderately high. They are easily tilled and produce well under irrigation, though their moisture-storage capacity is somewhat limited and only shallow cuts can be made in leveling. If the subsoil of the Judith soil is at or near the surface after leveling, large additions of fertilizer are needed because the subsoil is naturally high in lime but low in fertility. In such leveled areas, legumes respond better than other crops.

Suitable crops are small grain, alfalfa, a grass-legume mixture for hay or pasture, and corn for fodder or silage. Trees and shrubs generally grow well because their roots reach the deep moisture below the surface.

Border irrigation is most suitable for small grain, hay, and pasture, but corn can be irrigated best by furrows. These soils are also suited to sprinkler irrigation.

CAPABILITY UNIT IIs–2, IRRIGATED

This capability unit consists of deep, dark-colored silty clays on nearly level slopes. These soils are—

Savage silty clay, 0 to 2 percent slopes.
Terrad silty clay, 0 to 2 percent slopes.

These soils take in water at the moderately slow saturated intake rate of about half an inch per hour. They can hold about 2¼ inches of available moisture per foot of soil, or a total of 6¾ inches in the top 3 feet. Their natural fertility is high. Because they are clayey, these soils are somewhat difficult to work.

Suitable crops are small grain, alfalfa, grass-legume hay or pasture, and corn for fodder or silage.

A border system of irrigation is suitable for small grain, hay, and pasture. Corn is best irrigated by furrows.

CAPABILITY UNIT IIs–3, IRRIGATED

Only Judith gravelly clay loam, 0 to 2 percent slopes, is in this capability unit. It is deep, dark colored, and underlain by pebbles mixed with material finer than sand at a depth of 15 to 30 inches.

This soil takes in water at the moderately high saturated intake rate of about 2 inches per hour. Above the gravel, it can store about 1½ inches of available moisture per foot, but in the gravel the storage capacity decreases to about half an inch per foot. The content of organic matter is fairly low, and the subsoil is high in lime. Tillage is easy, but the gravel at the surface interferes somewhat with the mowing and raking of hay and with the combining of short barley and other short crops.

Suitable crops are small grain, alfalfa, grass-legume hay or pasture, and corn for fodder or silage. Trees and shrubs grow well in windbreaks.

If this soil is leveled for irrigation, and the limy subsoil is left near the surface, large amounts of fertilizer are needed to maintain yields. Legumes respond better than other crops if the limy subsoil is near the surface. A border system of irrigation can be used where this soil has been leveled and seeded to small grain, hay, and pasture, but corn is best irrigated by furrows. This soil is

also suited to sprinkler irrigation. More and lighter applications of water are needed on this soil than on soils free of gravel.

CAPABILITY UNIT IIc-3, IRRIGATED

This capability unit consists of deep, dark-colored, well-drained clay loams and silty clay loams on nearly level slopes. These soils are—

Danvers clay loam, 0 to 2 percent slopes.
Fergus clay loam, 0 to 2 percent slopes.
Judith clay loam, 0 to 2 percent slopes.
Savage silty clay loam, 0 to 2 percent slopes.
Straw clay loam, 0 to 2 percent slopes.
Twin Creek clay loam, 0 to 2 percent slopes.

These soils take in water at the moderate saturated intake rate of about 1½ inches per hour. They generally can hold about 2 inches of available moisture per foot in the top 3 feet of soil, but in the third foot of the Danvers and Judith soils, the moisture storage may be 1 inch or less, depending on the depth to the underlying gravelly material. The natural fertility of these soils is generally high. The subsoil of the Danvers and Judith soils is high in lime.

Suitable crops are small grain, alfalfa, grass-legume hay or pasture, and corn for fodder or silage. Trees and shrubs also grow well.

If the Danvers and Judith soils are leveled for irrigation, and the limy subsoil is left at or near the surface, large amounts of fertilizer are needed to maintain yields. Legumes respond better than other crops if the limy subsoil is near the surface. A border system of irrigation is well suited to all crops except corn, which can be irrigated best by furrows. These soils are also suited to sprinkler irrigation.

CAPABILITY UNIT IIIe-6, IRRIGATED

This capability unit consist of deep, black loams on gentle slopes. These soils are—

Adel silt loam, terrace.
Bridger loam, 2 to 4 percent slopes.
Raynesford and Adel loams, 2 to 4 percent slopes.

These soils take in water at the moderately high saturated intake rate of about 2 inches per hour. Except for the Bridger soil, they can hold about 2 inches of available moisture per foot in the top 3 feet of soil. The Bridger soil can hold 2 inches in the top 2 feet but only 1 or 1½ inches in the third foot. The natural fertility of all these soils is high. The growing season is short, slightly more than 95 days.

Suitable crops are winter wheat, barley, oats, alfalfa, and a grass-legume mixture for hay or pasture.

A border system can be used to irrigate a grass-legume mixture grown for hay or pasture. Irrigation through contour ditches is most suitable for small grain. Care and planning are necessary to avoid erosion and to insure good distribution of irrigation water.

CAPABILITY UNIT IIIe-7, IRRIGATED

This capability unit consists of deep, dark-colored, loamy soils on gentle slopes. These soils are—

Danvers clay loam, 2 to 4 percent slopes.
Fergus clay loam, 2 to 4 percent slopes.
Judith clay loam, 2 to 4 percent slopes.
Savage silty clay loam, 2 to 4 percent slopes.
Straw clay loam, 2 to 4 percent slopes.
Twin Creek loam, 2 to 4 percent slopes.

These soils take in water at the moderate saturated intake rate of about 1½ inches per hour. They can hold 2 inches of available moisture per foot in the first 3 feet of soil, but this storage capacity decreases to about 1½ inches in the fifth foot. The natural fertility of these soils is high. The subsoil of the Danvers and Judith soils is high in lime.

Suitable crops are wheat, barley, oats, alfalfa, grass-legume hay or pasture, and corn for fodder or silage.

If the Danvers and Judith soils are leveled for irrigation, and the limy subsoil is left at or near the surface, large amounts of fertilizer are needed to maintain yields. Legumes respond better than other crops if the limy subsoil is near the surface. The border system of irrigation can be used on grass-legume hay or pasture. Contour ditches are more suitable for irrigating small grain, and furrows or contour furrows are more suitable for irrigating corn. These soils are also suited to sprinkler irrigation. In applying irrigation water, special care is needed to avoid water erosion.

CAPABILITY UNIT IIIe-8, IRRIGATED

Only Savage silty clay, 2 to 4 percent slopes, is in this capability unit. It is deep and dark colored.

This soil takes in water at the moderately slow saturated intake rate of about 0.8 inch per hour. It can hold 2.8 inches of available moisture per foot in the top 3 feet of soil, but this storage capacity decreases to 1½ to 2 inches in the fourth or fifth foot. The natural fertility is high.

Suitable crops are small grain, alfalfa, grass-legume hay or pasture, and corn for fodder or silage.

A border system with short runs can be used on the grass-legume hay or pasture, but closely spaced contour ditches are needed for irrigating grain. Corn can be irrigated best by furrows or contour furrows. Because this soil erodes easily, water should be applied with special care.

CAPABILITY UNIT IIIe-9, IRRIGATED

This capability unit consists of generally deep, dark-colored cobbly and gravelly clay loams on nearly level to gentle slopes. These soils are—

Danvers cobbly clay loam, 0 to 4 percent slopes.
Judith cobbly clay loam, 0 to 4 percent slopes.
Judith cobbly clay loam, low terrace, 0 to 4 percent slopes.
Judith gravelly clay loam, 2 to 4 percent slopes.
Judith gravelly clay loam, low terrace, 0 to 4 percent slopes.

These soils take in water at the moderately high saturated intake rate of 2 inches per hour. Above the gravel they can store about 1½ inches of moisture per foot of soil, but in the gravel this storage capacity decreases to about half an inch per foot. The gravel and cobblestones at the surface interfere with the mowing and raking of hay and are rough on tillage and harvesting implements. The subsoil of the Danvers and Judith soils are high in lime.

Suitable crops are small grain, alfalfa, grass-legume hay or pasture, and corn for fodder or silage.

Because the gravel is near the surface in some places, cuts for leveling should be shallow. If the limy subsoil of these soils is left at or near the surface, large amounts of fertilizer are needed to maintain yields. Legumes respond better than other crops if the limy subsoil is near the surface. A border system of irrigation can be used on grass-legume hay or pasture, but contour ditches are most

suitable for irrigating small grain. Corn can be irrigated best by furrows or contour furrows. These soils are also well suited to sprinkler irrigation. More frequent and lighter applications of water are needed on these soils than on nongravelly soils. The water should be applied with special care to avoid erosion.

CAPABILITY UNIT IVe-6, IRRIGATED

This capability unit consists of deep, black loams on moderate to moderately steep slopes that range from 4 to 15 percent. These soils are—

Adel loam, 2 to 8 percent slopes.
Adel loam, 8 to 18 percent slopes.
Bridger loam, 4 to 15 percent slopes.
Raynesford and Adel loams, 4 to 8 percent slopes.
Raynesford and Adel loams, 8 to 15 percent slopes.

These soils take in water at the moderately high saturated intake rate of about 2 inches per hour. Except for the Bridger soil, they hold 2 inches of available moisture per foot in the top 3 feet of soil. The Bridger soil holds only 1 or 1½ inches in the third foot. The natural fertility of these soils is high, but the growing season is slightly more than 95 days.

Grass-legume hay or pasture and small grain are suitable crops.

Suitable for irrigation is a system of closely spaced contour ditches in which the water is well controlled. The water should be applied with utmost care because erosion is a problem on the irrigated slopes.

CAPABILITY UNIT IVe-7, IRRIGATED

This capability unit consists of deep, dark-colored, loamy soils on moderate to moderately steep slopes that range from 4 to 15 percent. These soils are—

Fergus clay loam, 4 to 8 percent slopes.
Fergus clay loam, 8 to 15 percent slopes.
Judith clay loam, 4 to 8 percent slopes.
Savage silty clay loam, 4 to 8 percent slopes.
Twin Creek loam, 4 to 8 percent slopes.

These soils take in water at the moderate saturated intake rate of about 1½ inches per hour. They can generally store about 2 inches of available moisture per foot in the top 3 feet of soil, but the Judith soil holds a little less. It probably can hold 1½ inches in the top 2 feet and half an inch in the third foot. The natural fertility of these soils is moderately high.

Suitable crops are grass-legume hay or pasture and small grain.

A carefully managed system of closely spaced contour ditches can be used for irrigation. Sprinkler irrigation is also suitable. The water should be applied with utmost care because erosion is a problem on irrigated slopes, and good distribution of water is needed.

CAPABILITY UNIT IVe-8, IRRIGATED

This capability unit consists of dark-colored, granular, clayey soils on moderate slopes. These soils are—

Promise clay, 2 to 8 percent slopes.
Savage silty clay, 4 to 8 percent slopes.

These soils take in water at the saturated intake rate of about 0.8 inch per hour. They can hold about 2 inches of available moisture per foot in the top 3 feet of soil. Their natural fertility is moderately high.

Suitable crops are grass-legume hay or pasture and small grain.

These soils can be irrigated by a system of closely spaced contour ditches in which the water is well controlled. Sprinkler irrigation also can be used satisfactorily. The utmost care is needed to minimize erosion where these soils are irrigated.

CAPABILITY UNIT IVe-9, IRRIGATED

This capability unit consists of deep, dark-colored cobbly and gravelly clay loams on moderate to moderately steep slopes. These soils are—

Danvers cobbly clay loam, 4 to 8 percent slopes.
Danvers cobbly clay loam, 8 to 15 percent slopes.
Judith gravelly clay loam, 4 to 8 percent slopes.

These soils take in water at the moderate saturated intake rate of about 1½ to 2 inches per hour. They can store about 1½ inches per foot in the top 2 feet of soil and about half an inch per foot in underlying gravelly material. The natural fertility of these soils is moderately high. The pebbles and cobblestones at the surface of these soils interfere somewhat with cultivation, but they also help to hold the soil in place. Water erosion, however, is a serious problem.

Grass-legume hay or pasture and small grain are suitable crops.

Closely spaced contour ditches are suitable for irrigating these soils. Where water is available, sprinkler irrigation is also well suited.

Predicted yields of irrigated crops

Table 3 lists for two levels of management the predicted yields of the principal irrigated crops grown in the survey area. In columns A are predicted average yields that are obtained by using the prevailing management. Columns B give the predicted yields that may be obtained under improved management.

Under the prevailing management, hay is generally cut for more than 6 years without reestablishment. Irrigation water generally is not applied regularly or uniformly. Fertilizer is not used. Improved management, in contrast, provides for periodic reestablishment of hay stands every 4 to 6 years, better irrigation, and the use of fertilizer.

Use and Management of Soils for Range [3]

In this subsection the rangeland in the survey area is briefly described, and then range sites and condition classes are defined. Each range site in the survey area is discussed, and its annual yield per acre, when in excellent condition, is estimated. Finally, general practices of range management are discussed.

In Judith Basin County more than 60 percent of the land area outside of the Lewis and Clark National Forest is used to produce range forage. This forage largely supports livestock, which is the second largest enterprise in the county. The rangeland generally is not suitable for cultivation, but a few parts of the old ranches that remain mostly in native grass can be cultivated.

In the foothills, range forage is the principal crop. Most ranches are confined to the southwestern edge of

[3] By STERLE E. DALE, range conservationist, Soil Conservation Service.

TABLE 3.—*Predicted average acre yields of principal irrigated crops under prevailing and improved management*

[In columns A are yields under prevailing management; in columns B are yields that could be obtained under improved management Absence of yield indicates soil is not suited to crop. Only soils suited to irrigation are listed in this table]

Map symbol	Soil	Oats		Smooth bromegrass hay		Alfalfa hay or alfalfa-smooth bromegrass hay	
		A	B	A	B	A	B
		Bu.	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Ak	Adel loam, 2 to 8 percent slopes	75	90	1. 5	3. 5	1. 8	3. 8
Al	Adel loam, 8 to 18 percent slopes	65	80	1. 2	2. 0	1. 2	2. 0
Am	Adel silt loam, terrace	80	100	2. 0	3. 5	2. 0	4. 0
Bp	Bridger loam, 2 to 4 percent slopes	80	100	1. 5	3. 2	1. 5	3. 5
Br	Bridger loam, 4 to 15 percent slopes	65	80	1. 2	2. 0	1. 2	2. 0
Da	Danvers clay loam, 0 to 2 percent slopes	90	110	2. 0	3. 5	2. 0	4. 0
Db	Danvers clay loam, 2 to 4 percent slopes	80	95	1. 5	3. 2	1. 5	3. 5
Dd	Danvers cobbly clay loam, 0 to 4 percent slopes	75	90	1. 5	3. 0	1. 5	3. 5
Df	Danvers cobbly clay loam, 4 to 8 percent slopes	50	60	1. 2	2. 5	1. 2	3. 0
Dg	Danvers cobbly clay loam, 8 to 15 percent slopes	60	75	1. 0	2. 0	1. 0	2. 8
Fc	Fergus clay loam, 0 to 2 percent slopes	90	110	2. 0	3. 5	2. 0	4. 0
Fd	Fergus clay loam, 2 to 4 percent slopes	80	95	1. 5	3. 2	1. 5	3. 5
Ff	Fergus clay loam, 4 to 8 percent slopes	65	80	1. 2	2. 5	1. 2	3. 0
Fh	Fergus clay loam, 8 to 15 percent slopes	60	70	1. 2	2. 5	1. 5	3. 0
Ga	Gallatin clay loam [1]	80	100	2. 0	3. 5	----	----
Gb	Gallatin loam [1]	80	100	2. 0	3. 5	----	----
Jb	Judith clay loam, 0 to 2 percent slopes	80	100	2. 0	3. 5	2. 0	4. 0
Jc	Judith clay loam, 2 to 4 percent slopes	60	95	1. 5	3. 2	1. 5	3. 5
Jd	Judith clay loam, 4 to 8 percent slopes	50	80	1. 2	2. 0	1. 2	2. 2
Jf	Judith clay loam, low terrace	70	90	1. 5	3. 0	1. 5	3. 0
Jh	Judith cobbly clay loam, 0 to 4 percent slopes	65	80	1. 2	2. 0	1. 2	2. 0
Jk	Judith cobbly clay loam, low terrace, 0 to 4 percent slopes	65	80	1. 2	2. 0	1. 2	2. 0
Jl	Judith gravelly clay loam, 0 to 2 percent slopes	75	90	1. 5	3. 0	1. 5	3. 0
Jm	Judith gravelly clay loam, 2 to 4 percent slopes	65	80	1. 5	2. 5	1. 5	2. 5
Jn	Judith gravelly clay loam, 4 to 8 percent slopes	50	70	1. 0	2. 0	1. 2	2. 2
Jo	Judith gravelly clay loam, low terrace, 0 to 4 percent slopes	70	90	1. 5	3. 0	1. 5	3. 0
Po	Promise clay, 2 to 8 percent slopes	75	90	2. 0	3. 0	1. 5	3. 5
Ra	Raynesford and Adel loams, 2 to 4 percent slopes	80	100	1. 5	3. 2	1. 5	3. 5
Rd	Raynesford and Adel loams, 4 to 8 percent slopes	65	80	1. 2	2. 5	1. 5	3. 0
Rf	Raynesford and Adel loams, 8 to 15 percent slopes	65	80	1. 2	2. 0	1. 2	2. 0
Sd	Savage silty clay, 0 to 2 percent slopes	90	110	2. 0	3. 5	2. 0	4. 0
Se	Savage silty clay, 2 to 4 percent slopes	80	95	2. 0	3. 2	2. 0	3. 5
Sf	Savage silty clay, 4 to 8 percent slopes	65	80	2. 0	3. 0	1. 5	3. 0
Sg	Savage silty clay loam, 0 to 2 percent slopes	80	100	2. 0	3. 5	2. 0	4. 0
Sh	Savage silty clay loam, 2 to 4 percent slopes	80	95	2. 0	3. 2	2. 0	3. 5
Sk	Savage silty clay loam, 4 to 8 percent slopes	65	80	1. 8	2. 5	1. 8	3. 0
Sw	Straw clay loam, 0 to 2 percent slopes	80	100	2. 0	3. 5	2. 0	4. 0
Sx	Straw clay loam, 2 to 4 percent slopes	75	95	2. 0	3. 2	2. 0	3. 5
Sy	Straw clay loam, gravelly substratum	70	90	1. 5	3. 0	1. 5	3. 0
Tc	Terrad silty clay, 0 to 2 percent slopes	80	110	2. 0	3. 5	2. 0	4. 0
To	Twin Creek loam, 2 to 4 percent slopes	75	95	1. 8	3. 2	1. 8	3. 5
Tp	Twin Creek loam, 4 to 8 percent slopes	65	80	1. 5	2. 5	1. 8	3. 0
Tw	Twin Creek clay loam, 0 to 2 percent slopes	80	100	2. 0	3. 5	2. 0	4. 0

[1] This soil is also listed in the table for principal dryland crops (table 2) because it is in capability unit IIw–1, irrigated and nonirrigated.

the Stanford Bench or to the foothills of the Little Belt and Highwood Mountains. The range is gently rolling to steep and in some areas is dissected by deep drainageways. Also used mainly for grazing is the part of the survey area drained by Arrow Creek that is locally called the breaks. In addition, native pasture occurs along edges of terraces on many grain-producing farms.

On upland ranges in areas that normally have 15 to 19 inches of precipitation annually, the original, or climax, vegetation consisted primarily of mixed tall, mid, and short grasses and smaller amounts of perennial forbs and other plants used for browse. The proportions of the different kinds of vegetation varied according to the characteristics of the soils in a site, especially the content of moisture.

After the rangeland in the county was grazed for about three-quarters of a century, it deteriorated in varying degrees. Today much of the range produces only about half of the forage that it can produce. Fortunately, in many areas enough of the high-producing original vegetation remains for the range to be restored, through sound management, to nearly its original productivity.

Range site and condition class

Most areas of range consist of several kinds of soils, each having a different potential for producing native forage. Throughout the years, ranchers have evaluated their rangeland, often successfully, by the process of trial and error. More recently, however, a method has been devised for classifying grassland into range sites. A range

site is a kind of rangeland that differs from other kinds of rangeland in its ability to produce different kinds and proportions of plants that grew in the original vegetation. If a rancher knows the kinds of rangeland, or the range sites, on his ranch, and also knows something about the soils that make up these range sites, he can estimate the productive potential of his ranch. For example, a ranch made up mostly of the Subirrigated and Silty range sites can produce more and better forage than one made up mostly of the Thin Breaks and Very Shallow range sites.

Over a period of years, a range site generally produces the greatest amount of forage when the composition of its vegetation is nearly that of the original vegetation. The range plants in the vegetation can be classified according to the way they respond to grazing. A plant is called a *decreaser* if it decreases greatly when the range is grazed closely. It is called an *increaser* if it increases abundantly under close grazing. A plant that invades areas where it did not formerly grow is called an *invader*. The best rangeland has a large percentage of decreasers, some increasers, and few or no invaders. How a range has been managed in the past is reflected by its present vegetation.

The present condition of a range can be estimated by comparing the present vegetation on a site with the vegetation that originally grew there. Range condition is commonly expressed in four condition classes that are determined by the percentage of original, or climax, vegetation in the present vegetation. These four classes and the percentage of climax vegetation that determines them are as follows:

Condition class	*Percentage of climax vegetation*
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

The experience of ranchers and the results of research have shown that a range can be kept in good or excellent condition if not more than half of the weight of the forage produced in a year is grazed. If a range is grazed only moderately, the damage to the better kinds of forage plants is minimized and the condition of the range improves. The ungrazed forage is not wasted, for it does these things—

1. Enables plants to store food that is used for quick and vigorous growth in spring and following droughts.
2. Allows the better plants to maintain or improve their vigor.
3. Serves as a mulch that encourages rapid intake of moisture and an increase in the moisture stored.
4. Protects the soil from wind and water erosion.
5. Stops snow where it falls so that it melts and soaks into the soil for later use by plants.

Descriptions of the range sites

In the Judith Basin Area, the grassland occurs in two zones of precipitation—15 to 19 inches, and 20 to 24 inches. Although the Subirrigated, Shallow, Very Shallow, and other range sites lie in both zones, a distinction between the zones is not made because other factors minimize the effect of the difference in precipitation. Differences in precipitation, however, are important on the Silty, Clayey, and Thin Breaks range sites, and the sites in the two precipitation zones are designated by including "15 to 19 inches precipitation" or "20 to 24 inches precipitation" as a part of the site name.

In the discussion of each range site that follows are (1) a brief description of the lay of the land, (2) a list of the included soils, (3) some characteristics of the soils, (4) the dominant plants on the site when it is in excellent condition, and (5) the common invaders.

WETLAND RANGE SITE

Gallatin soils, wet, are the only soils in this range site. They occupy narrow areas on the low flood plains along some of the major streams. Drainage is poor, and the water table fluctuates between the surface and a depth of 2 feet.

The original, or climax, vegetation consisted of many kinds of decreasers and some increasers. The decreasers are prairie cordgrass, American mannagrass, northern reedgrass, tufted hairgrass, sedges, and other plants. Broad-leaved forbs and willows are some of the increasers. When this range site deteriorates, timothy, Kentucky bluegrass, western wheatgrass, foxtail barley, and other invaders replace the original plants. Because this range site seldom lacks moisture, the forage stays green throughout the growing season. This range site is often grazed so severely that its condition deteriorates.

SUBIRRIGATED RANGE SITE

This range site is on bottom lands along some of the major streams, in broad areas on low terraces, in upland swales, and in tiny ponded areas. It is nearly level and gently sloping. The soils in this site are kept continually moist by a water table that is 2 to 6 feet below the surface. This site is used mostly for both hay and grazing. A typical area is 5 miles north of Stanford. The soils are—

Bowdoin silty clay, low clay variant.
Colvin-Lamoure clay loams.
Dimmick clay.
Fargo-Hegne silty clays.
Gallatin clay loam.
Gallatin loam.
Gallatin loam, clay substratum.
Gallatin and Raynesford loams.
Slocum loam.
Wet land.

The original plant cover on this range site consisted of various combinations of decreasers and increasers. Northern reedgrass, tufted hairgrass, basin wildrye, and sedges were decreasers. Increasers originally present included inland saltgrass, western wheatgrass, mat muhly, and shrubby cinquefoil. The condition of the range worsened after many years of grazing in which the livestock selected their favorite grasses. The invaders that have replaced much of the original cover are redtop, timothy, foxtail barley, and Canada thistle.

SALINE SUBIRRIGATED RANGE SITE

This range site occupies areas along meandering streams, a few nearly level areas on low terraces, and swales and seepy slopes on the uplands. The soils are—

Arvada-Beckton complex, saline.
Loamy alluvial land.
Saline land.

These soils are poorly drained and contain enough salts to damage some plants. Salt-tolerant plants grow on much

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of the site. In places, particularly on the seepy uplands, the salts form a white crust at the surface. In other places the salts are not visible at the surface.

In the original plant cover of this range site there was a combination of decreasers and increasers. The decreasers included alkali sacaton, western wheatgrass, alkali bluegrass, Nuttall alkaligrass, and alkali cordgrass. Inland saltgrass and mat muhly were among the original increasers. When this range site deteriorates, the original plants are replaced entirely or partly by foxtail barley, American sloughgrass, saltbushes, and other invaders.

This range site is frequently abused through overgrazing because it seldom lacks moisture and the plants stay green throughout the growing season. Sometimes the deterioration is severe. Effective management should provide fencing and practices that encourage the growth of decreasers and increasers.

SILTY RANGE SITE, 15 TO 19 INCHES PRECIPITATION

This range site occupies parts of rolling uplands, the nearly level to sloping terraces and high benches, and smaller areas on fans. Elevations range from 3,800 feet above sea level on the most northeasterly benches to about 4,600 feet in the lower foothills. In some of the more sharply rolling areas, this site is closely intermingled with the Shallow range site, which is on the knolls, ridges, and crests. Favorable topography makes the site accessible to livestock, but most of it is cultivated. The soils are—

Absarokee clay loam, 2 to 8 percent slopes.
Absarokee clay loam, 8 to 15 percent slopes.
Absarokee-Cheadle channery loams, 2 to 8 percent slopes.
Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded.
Absarokee-Cheadle stony loams (Absarokee part).
Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes.
Bainville loam.
Beckton loam.
Blaine-Spring Creek loams, 2 to 8 percent slopes.
Blaine-Spring Creek stony loams (Blaine part).
Cheadle channery loam, 2 to 8 percent slopes.
Cheadle channery loam, 8 to 15 percent slopes.
Cheadle loam, 2 to 8 percent slopes.
Cheadle loam, 8 to 15 percent slopes.
Danvers clay loam, 0 to 2 percent slopes.
Danvers clay loam, 2 to 4 percent slopes.
Danvers clay loam, 4 to 8 percent slopes.
Danvers cobbly clay loam, 0 to 4 percent slopes.
Danvers cobbly clay loam, 4 to 8 percent slopes.
Danvers cobbly clay loam, 8 to 15 percent slopes.
Danvers gravelly clay loam, 0 to 4 percent slopes.
Danvers stony clay loam, 2 to 4 percent slopes.
Danvers-Judith clay loams, 0 to 2 percent slopes.
Danvers-Judith clay loams, 2 to 4 percent slopes.
Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes.
Danvers-Judith gravelly clay loams, 0 to 2 percent slopes.
Darret clay loam, 8 to 15 percent slopes.
Darrett stony clay loam.
Darret-Cheadle complex, 2 to 8 percent slopes.
Darret-Cheadle complex, 8 to 35 percent slopes.
Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Judith part).
Judith clay loam, 0 to 2 percent slopes.
Judith clay loam, 2 to 4 percent slopes.
Judith clay loam, 4 to 8 percent slopes.
Judith clay loam, low terrace.
Judith cobbly clay loam, 0 to 4 percent slopes.
Judith cobbly clay loam, low terrace, 0 to 4 percent slopes.
Judith gravelly clay loam, 0 to 2 percent slopes.
Judith gravelly clay loam, 2 to 4 percent slopes.
Judith gravelly clay loam, 4 to 8 percent slopes.
Judith gravelly clay loam, low terrace, 0 to 4 percent slopes.
Judith-Danvers gravelly clay loams, 0 to 4 percent slopes.
Judith and Savage soils.
Judith-Utica gravelly loams, 4 to 8 percent slopes.
Judith-Utica gravelly loams, 8 to 15 percent slopes.
Maginnis-Absarokee channery clay loams (Absarokee part).
Spring Creek-Blaine stony loams (Blaine part).
Straw clay loam, 0 to 2 percent slopes.
Straw clay loam, 2 to 4 percent slopes.
Straw clay loam, gravelly substratum.
Twin Creek loam, 2 to 4 percent slopes.
Twin Creek loam, 4 to 8 percent slopes.
Twin Creek loam, 8 to 15 percent slopes.
Twin Creek clay loam, 0 to 2 percent slopes.
Utica gravelly loam, 2 to 8 percent slopes.
Utica-Judith gravelly loams, sandy substratum.
Utica-Judith stony loams.

These soils are mainly loams and light clay loams that are more than 20 inches deep. Some of them are gravelly. They take in water readily, have good moisture-storage capacity, and have a good supply of plant nutrients.

Decreasers in the original plant community in this range site included rough fescue, bluebunch wheatgrass, mountain brome, big bluegrass, and Richardson needlegrass. Originally the decreasers made up from 50 to 75 percent of the vegetation on this site, and increasers made up practically all of the rest. Included among the increasers were Idaho fescue, western wheatgrass, needle-and-thread, plains reedgrass, and lupine. In ranges having a history of close use, plants that have invaded are cheatgrass brome, Japanese brome, curlycup gumweed, and fringed sagewort. These invaders grow separately or in combination.

CLAYEY RANGE SITE, 15 TO 19 INCHES PRECIPITATION

This range site occupies rolling uplands and nearly level to gently sloping terraces and high benches. Elevations range from 3,700 feet above sea level on some of the lower terraces to 4,500 feet in the lower foothills. Much of this site is cultivated. The soils are—

Absarokee silty clay, 2 to 8 percent slopes.
Arvada-Beckton cobbly clay loams (Beckton part).
Beckton-Arvada clay loams (Beckton part).
Beckton-Danvers clay loams.
Beckton-Savage complex.
Chama clay loam, 4 to 8 percent slopes.
Chama-Midway clay loams, 4 to 8 percent slopes.
Chama-Midway clay loams, 8 to 15 percent slopes.
Fergus clay loam, 0 to 2 percent slopes.
Fergus clay loam, 2 to 4 percent slopes.
Fergus clay loam, 4 to 8 percent slopes.
Fergus clay loam, 8 to 15 percent slopes.
Fergus silty clay loam, shale substratum, 2 to 8 percent slopes.
Pierre clay, 2 to 8 percent slopes.
Pierre clay, 8 to 35 percent slopes.
Promise clay, 0 to 2 percent slopes.
Promise clay, 2 to 8 percent slopes.
Promise clay, 8 to 15 percent slopes.
Promise cobbly clay.
Savage silty clay, 0 to 2 percent slopes.
Savage silty clay, 2 to 4 percent slopes.
Savage silty clay, 4 to 8 percent slopes.
Savage silty clay loam, 0 to 2 percent slopes.
Savage silty clay loam, 2 to 4 percent slopes.
Savage silty clay loam, 4 to 8 percent slopes.
Terrad clay, 2 to 8 percent slopes.
Terrad clay, 8 to 35 percent slopes.
Terrad silty clay, 0 to 2 percent slopes.
Winifred clay loam, 0 to 4 percent slopes.
Winifred clay loam, 4 to 8 percent slopes.
Winifred clay loam, 8 to 15 percent slopes.
Winifred cobbly clay loam, 2 to 8 percent slopes.
Winifred cobbly clay loam, 8 to 15 percent slopes.
Winifred-Judith clay loams.
Winifred-Rhoades clay loams.

These soils range from clay loam to clay and are more than 20 inches deep. Some of them are cobbly. They have a moderate to slow rate of water intake, but their moisture-storage capacity and supply of plant nutrients are good. Compaction by trampling of livestock is more likely on these soils than on coarser textured soils. If these soils are compacted, the rate of moisture intake is further reduced and more water is lost through runoff.

The decreasers in the original plant community on this range site were rough fescue, bluebunch wheatgrass, green needlegrass, and Canada wildrye. These decreasers made up 50 to 70 percent of the vegetation, and increasers made up the rest. The increasers included western wheatgrass, Idaho fescue, needle-and-thread, prairie junegrass, and plains reedgrass. If this range site is grazed too closely, is used too early in the grazing season, or both, some of the original decreasers and increasers do not survive. Invaders are quick to take advantage of the plant nutrients and available moisture that are left in the soils when the decreasers and increasers deteriorate. Among the common invaders are Kentucky bluegrass, Canada bluegrass, smooth brome, timothy, cheatgrass, and similar annuals, as well as broad-leaved annual forbs and noxious perennial weeds.

It is often advisable to fence large areas of this site because these areas require similar management that differs from the management of adjacent sites.

THIN SILTY RANGE SITE

This range site occupies the steep edges of benches on which occur the Silty and Clayey range sites having 15 to 19 inches precipitation. In many places the Thin Silty range site extends from the bench edges down to the Clayey range site on a bench below. Livestock prefer to graze the sites that have the more gentle slopes. The soils are—

Darret-Utica complex.
Utica gravelly loam, 8 to 35 percent slopes.

These soils have a thin, dark surface layer that grades to deep, very gravelly fine material. Although they take in water readily, much of it runs off because slopes are steep. The moisture-storage capacity is low.

Some or all of the decreasers in the original plant community were green needlegrass, bearded wheatgrass, bluebunch wheatgrass, and rough fescue. Among the increasers were western wheatgrass, Idaho fescue, needle-and-thread, prairie junegrass, plains reedgrass, and blue grama. When the range deteriorated because of overgrazing, invaders replaced many decreasers and increasers. These invaders include cheatgrass brome, red three-awn, needle-leaf sedge, curlycup gumweed, and broom snakeweed. In some places there are various noxious weeds, including leafy spurge and Russian knapweed.

THIN CLAYEY RANGE SITE

This range site occupies small areas of hilly uplands and steep edges or benches. Slopes are more than 15 percent. The site adjoins large areas of the Silty and Clayey range sites that have 15 to 19 inches precipitation and the more gentle slopes that livestock prefer to graze. The soils are—

Maginnis cobbly clay loam.
Midway clay loam.
Winifred-Utica clay loams.

These soils have a thin surface layer of clay loam or cobbly clay loam that grades to weathered clay loam shale or fine material containing many pebbles. In many places on the bench edges, there are small areas of soils shallow over hard shale. The soils in this range site are moderately slow in permeability. Runoff is rapid, and much of the snow that falls blows off. Consequently, the soils are droughty.

Decreasers in the original plant community were rough fescue, Canada wildrye, basin wildrye, green needlegrass, and bluebunch wheatgrass. Increasers that have been on the range site in various amounts include western wheatgrass, Idaho fescue, timber danthonia, prairie junegrass, plains reedgrass, and plains muhly. In areas that have been grazed closely and have deteriorated are many invaders, including cheatgrass brome, Kentucky bluegrass, needleleaf sedge, broom snakeweed, curlycup gumweed, Canada thistle, leafy spruge, and Russian knapweed.

SHALLOW CLAY RANGE SITE

Lismas-Pierre clays are the only soils in this range site. The site occurs in small areas on sharply rolling uplands. It is grazed with areas of the adjoining Shale range site and the Silty and Clayey range sites having 15 to 19 inches precipitation. Because slopes are steep, livestock graze this range site only after the Silty and Clayey sites have been grazed closely.

The soils on this range site consist of clay that overlies shale at a depth of 6 to 18 inches. Small areas of shale are commonly exposed. Because the rate of water intake is slow and slopes are steep, considerable moisture is lost in runoff. The organic-matter content is fairly low. Roots cannot penetrate these soils deeply.

The decreasers originally on this range site included bluebunch wheatgrass, rough fescue, green needlegrass, Canada wildrye, and mountain brome. Increasers included western wheatgrass, Idaho fescue, needle-and-thread, prairie junegrass, and plains reedgrass. Where the range is depleted because of overgrazing, cheatgrass brome, curlycup gumweed, broom snakeweed, and other plants probably have invaded.

SHALLOW TO GRAVEL RANGE SITE

Only Cobbly alluvial land is in this range site. It occupies narrow areas of the flood plains fairly close to the mountains. In most places these areas are along the larger streams. This site is likely to be flooded occasionally.

The soils on this site consist of very cobbly material that is of variable texture and is 10 to 20 inches thick. They are underlain by loose, clean coarse sand and gravel. These soils take in water rapidly but are droughty because little of it is stored. The original decreasers included bluebunch wheatgrass, western wheatgrass, and spike fescue. Increasers included needle-and-thread, timber danthonia, prairie junegrass, and plains reedgrass. The invaders in the areas in poor condition include cheatgrass brome, needleleaf sedge, fringed sagewort, Canada thistle, and noxious weeds.

The range site is not extensive and is usually managed the same way as adjoining range sites.

SHALLOW RANGE SITE

This range site occupies ridges, knolls, and crests of uplands and, to a lesser extent, gentle slopes of high

benches. Commonly this site is adjacent to the Silty range site, 15 to 19 inches precipitation, which occupies the lower slopes of the rolling or sharply rolling uplands. The Shallow range site generally is not grazed so closely as the Silty range site. The soils are—

Absarokee-Cheadle stony loams (Cheadle part).
Alder-Maginnis complex, 8 to 35 percent slopes (Maginnis part).
Ashuelot gravelly loam.
Blaine-Spring Creek stony loams (Spring Creek part).
Cheadle stony loam.
Duncom stony loam.
Hughesville-Duncom complex (Duncom part).
Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Ashuelot part).
Maginnis-Absarokee channery clay loams (Maginnis part).
Maginnis-Alder channery clay loams (Maginnis part).
Sapphire-Cheadle complex (Cheadle part).
Skaggs-Cheadle complex (Cheadle part).
Skaggs-Duncom stony clay loams (Duncom part).
Skaggs-Duncom-Hughesville complex (Duncom part).
Spring Creek-Blaine stony loams (Spring Creek part).
Teton-Cheadle stony loams, 15 to 35 percent slopes (Cheadle part).
Woodhurst-Spring Creek stony complex (Spring Creek part).

These soils are loamy and shallow over hard rock that is practically impenetrable. Most of them are stony or gravelly and have a limy root zone. The supply of plant nutrients is only fair. These soils take in water readily but their moisture-storage capacity is low because the soils are shallow. Consequently, the soils are droughty. Runoff is rapid on the steeper slopes.

Decreasers in the original plant community included bluebunch wheatgrass, rough fescue, bearded wheatgrass, mountain brome, and spike fescue. Increasers included Idaho fescue, western wheatgrass, needle-and-thread, timber danthonia, prairie junegrass, and plains reedgrass. Cheatgrass brome, timothy, needleleaf sedge, curlycup gumweed, and broom snakeweed are invaders generally found on ranges having a history of overuse.

PANSPOTS RANGE SITE

This range site occurs on nearly level stream terraces and gently sloping fans. It consists of areas in grass closely intermingled with barren spots, or slick spots, that cover 15 to 40 percent of the range site. The soils are—

Arvada-Laurel complex.
Rhoades-Arvada complex.

The areas in grass consist of a thin and moderately thick surface layer of loam or clay loam that is underlain by a slowly permeable subsoil. The slick spots have little or no vegetation and consist of salty clay or other hard material that is nearly impervious to water and roots.

Western wheatgrass and needle-and-thread were decreasers in the original plant community. Increasers included prairie junegrass, Sandberg bluegrass, plains reedgrass, and blue grama. Invaders in areas that have been overgrazed for years are cheatgrass brome, Japanese brome, Kentucky bluegrass, and red three-awn.

This site is not extensive and generally is managed the same way as adjoining range sites.

DENSE CLAY RANGE SITE

This range site occurs on fans and terraces and, to a lesser extent, on the uplands, largely in the plains section. It is commonly intermingled with the Silty range site, 15 to 19 inches precipitation. The soils are—

Arvada-Beckton cobbly clay loams (Arvada part).
Arvada-Terrad clays.
Beckton-Arvada clay loams (Arvada part).
Clayey alluvial land.

These soils consist of dispersed clay throughout the profile, or they have a thin clay loam surface layer and a dispersed clay subsoil. Because they tend to seal when moistened, they take in water very slowly. They are low in content of organic matter, and varying amounts of salts occur in their subsoil. Roots cannot penetrate deeply.

The original plant community contained bluebunch wheatgrass and similar decreasers. Increasers on range in excellent condition include western wheatgrass, plains reedgrass, blue grama, and Sandberg bluegrass. Cheatgrass brome, tumblegrass, curlycup gumweed, and broom snakeweed are usually present on ranges that have been abused for a long time.

THIN BREAKS RANGE SITE, 15 TO 19 INCHES PRECIPITATION

This range site occupies broken slopes on the edges of the upland plains. It is at elevations of less than 5,000 feet above sea level. Different kinds of rock crop out at different levels on the slopes. The more gentle slopes of this site are easily accessible to livestock, but the steeper slopes are more difficult to graze. The soils are—

Cheadle-Big Timber-Rock outcrop complex.
Midway-Shale outcrop complex.

On the steep and moderately steep slopes, the soils between the rock ledges are loam and clay loam 10 to 30 inches deep. Moisture-storage capacity is low to moderate, and considerable moisture is lost in runoff.

Decreasers in the original vegetation on this range site included bluebunch wheatgrass, Idaho fescue, green needlegrass, bearded wheatgrass, mountain brome, slender wheatgrass, and prairie sandreed. Increasers on range in excellent condition include western wheatgrass, needle-and-thread, plains reedgrass, prairie junegrass, and blue grama. Invaders that sometimes occur today include cheatgrass brome, Kentucky bluegrass, and timothy.

This range site is seldom grazed alone but usually is grazed with adjoining range sites. The grazing is generally moderate because of the steep slopes and poor accessibility.

VERY SHALLOW RANGE SITE

This range site occupies steep and very steep, broken slopes on edges of high plateaus and on canyon walls. The soils are—

Cheadle-Rock outcrop complex.
Duncom-Rock outcrop complex.

The soils are loams and stony loams that dominantly are 6 to 12 inches deep over hard, impenetrable rock. Deeper soils occur in coves and at the bases of slopes. Rock crops out in 30 to 50 percent of the site. The soils have very low moisture-storage capacity.

Decreasers in the original plant community included bluebunch wheatgrass, western wheatgrass, Idaho fescue, mountain brome, prairie sandreed, and needle-and-thread. The most common increasers are blue grama, prairie junegrass, and Sandberg bluegrass. If invaders occur today, they include cheatgrass brome, Kentucky bluegrass, curlycup gumweed, and broom snakeweed.

This range site is usually in good or excellent condition partly because of its steep topography. Compared to most

other range sites, the site is inaccessible. Livestock closely graze most adjoining range sites before making even moderate use of this site.

SHALE RANGE SITE

Lismas-Shale outcrop complex makes up this range site. The site typically occupies steep, hilly breaks that are dissected by coulees, or dry creekbeds. The soil material is shallow clays and clay shale mixed in about equal amounts. Runoff is rapid because the shallow clays have slow to very slow water intake and because slopes are steep. Livestock are not likely to graze this range site.

Decreasers in the original plant community included prairie sandreed, western wheatgrass, Indian ricegrass, green needlegrass, and bluebunch wheatgrass. The most common increasers were Sandberg bluegrass, blue grama, American vetch, and mountain thermopsis. Yellow sweetclover and cheatgrass brome are among the invaders that may occur.

This range site is not extensive, and generally it is grazed with adjoining range sites.

SILTY RANGE SITE, 20 TO 24 INCHES PRECIPITATION

This range site occupies rolling uplands and small areas on fans in the higher foothills of the survey area. Elevations range from 4,600 to 6,000 feet above sea level. Some areas of this site are cultivated. The soils are—

Adel loam, 2 to 8 percent slopes.
Adel loam, 8 to 18 percent slopes.
Adel silt loam, terrace.
Alder clay loam, 2 to 8 percent slopes.
Alder clay loam, 8 to 15 percent slopes.
Alder stony clay loam, 8 to 15 percent slopes.
Alder-Maginnis channery clay loams, 2 to 8 percent slopes.
Alder-Maginnis complex, 8 to 35 percent slopes (Alder part).
Blythe loam, 2 to 4 percent slopes.
Blythe loam, 4 to 8 percent slopes.
Bridger loam, 2 to 4 percent slopes.
Bridger loam, 4 to 15 percent slopes.
Bridger stony loam.
Judith and Raynesford stony loams, 2 to 8 percent slopes.
Judith and Raynesford stony loams, 8 to 15 percent slopes.
Little Horn stony loam.
Maginnis-Alder channery clay loams (Alder part).
Raynesford and Adel loams, 2 to 4 percent slopes.
Raynesford and Adel loams, 4 to 8 percent slopes.
Raynesford and Adel loams, 8 to 15 percent slopes.
Raynesford and Adel stony loams, 4 to 15 percent slopes.
Skaggs loam.
Skaggs clay loam, 4 to 8 percent slopes.
Skaggs clay loam, 8 to 15 percent slopes.
Skaggs stony clay loam.
Skaggs-Cheadle complex (Skaggs part).
Skaggs-Duncom stony clay loams (Skaggs part).
Skaggs-Raynesford loams, 8 to 35 percent slopes.
Skaggs-Duncom-Hughesville complex (Skaggs part).
Teton loam, 2 to 8 percent slopes.
Teton loam, 8 to 15 percent slopes.
Teton-Adel stony loams.
Teton-Cheadle channery loams, 4 to 15 percent slopes.
Teton-Cheadle stony loams, 4 to 15 percent slopes.
Teton-Cheadle stony loams, 15 to 35 percent slopes (Teton part).
Woodhurst stony loam.
Woodhurst-Alder stony complex.
Woodhurst-Loberg complex (Woodhurst part).
Woodhurst-Spring Creek stony complex (Woodhurst part).
Woodhurst-Teton-Cheadle soils.

These soils are loams, light clay loams, and silt loams that are more than 20 inches deep. Some of them are channery and some are stony. They take in water readily and have good moisture-storage capacity. The supply of plant nutrients is good.

Decreasers in the original plant community included purple reedgrass, mountain brome, rough fescue, subalpine needlegrass, bearded wheatgrass, slender wheatgrass, and tufted hairgrass. They amounted to 70 to 80 percent of the total annual production. Among the increasers were Idaho fescue, timber danthonia, needle-and-thread, and lupine. Invaders crowd out the original vegetation when the range is overused because moisture is favorable for their growth during the grazing season when decreasers are grazed closely and continuously and are destroyed. The invaders include Kentucky bluegrass, timothy, smooth broom, and needleleaf sedge.

This range site is very productive. It should be fenced separately so that it can be managed well and kept in excellent condition. If adjoining steep range sites are managed to obtain full use of their grasses, this range site deteriorates because it is grazed closer and closer, and the adjoining steep sites are little used. Water is usually plentiful, and when it is not, springs and seeps are generally available.

CLAYEY RANGE SITE, 20 TO 24 INCHES PRECIPITATION

This range site occupies rolling and hilly uplands and sloping fans in the foothills. Elevations range from 5,000 to 5,700 feet above sea level. More forage grows in small seeps that occur than in the rest of the site. The soils are—

Castle clay, 4 to 15 percent slope.
Castle clay, 15 to 35 percent slope.
Castle complex.

These soils consist of clays that are more than 20 inches thick. They have deep cracks when dry, but these cracks close as the soils are moistened by rain. The rate of water intake therefore is slow, and it decreases when the moist soils are compacted by the trampling of livestock. Much water is lost in runoff, but the capacity to store moisture is good. Root penetration is more difficult than in the coarser textured soils.

Decreasers in the original plant community included rough fescue, bluebunch wheatgrass, Richardson needlegrass, Columbia needlegrass, mountain brome, bearded wheatgrass, and slender wheatgrass. These decreasers made up from 60 to 75 percent of the annual production of herbage. Increasers included Idaho fescue, timber danthonia, prairie junegrass, needle-and-thread, lupine, Douglas-fir, limber pine, and ponderosa pine. When this range site deteriorates from overuse, Kentucky bluegrass, timothy, one-spike danthonia, and needleleaf sedge invade and make use of the soil moisture and plant nutrients.

This is one of the more productive upland range sites in the 20- to 24-inch precipitation zone. Areas large enough to justify fencing should be fenced off from other range sites. If this site is surrounded by steeper, less productive range sites, uniform grazing of all sites is difficult. If the steeper sites are fully used, this range site is overgrazed and deteriorates.

THIN BREAKS RANGE SITE, 20 TO 24 INCHES PRECIPITATION

This range site occurs on broken slopes high in the foothills and in mountainous areas at elevations generally more than 500 feet above sea level. Rocks of different kinds crop out at different levels on the slopes. The more gentle

slopes are easily grazed by livestock, but grazing is more difficult on the steeper ones. The soils are—

Cheadle-Duncom-Rock outcrop complex.
Duncom-Skaggs-Rock outcrop complex.

Outcrops of shale and other rock cover 15 to 30 percent of most areas. Between the rock ledges and shale outcrops the soils are loam and clay loam that range from 10 to 36 inches in depth. These soils take in water quite readily, but runoff is generally rapid because slopes are steep and moderately steep. The moisture-storage capacity varies with the depth of soil.

Decreasers in the original plant community included bearded wheatgrass, Richardson needlegrass, bluebunch wheatgrass, subalpine needlegrass, purple reedgrass, tufted hairgrass, and basin wildrye. Increasers included western wheatgrass, Idaho fescue, timber danthonia, prairie junegrass, needle-and-thread, lupine, and shrubby cinquefoil. When the range was in poor condition, the invaders replaced the original vegetation. These invaders include Kentucky bluegrass, timothy, one-spike danthonia, needleleaf sedge, curlycup gumweed, and broom snakeweed.

Estimated annual yield on each range site

Annual yields of forage are affected mainly by the amount and distribution of precipitation during the year. They are also affected by the amount of past grazing, by trampling, and by the activity of rodents and insects. Because these factors vary, yields of forage vary from year to year, but a fairly accurate estimate of the annual yields can be made. Following are the annual yields, in pounds (air dry) per acre, on the range sites in the survey area:

Range site:	*Pounds (air dry) per acre*
Wetland	5,000 to 7,000
Subirrigated	4,000 to 6,000
Saline Subirrigated	3,000 to 5,000
Silty, 15 to 19 inches precipitation	1,900 to 2,400
Clayey, 15 to 19 inches precipitation	1,800 to 2,300
Thin Silty	1,500 to 1,900
Thin Clayey	1,400 to 1,800
Shallow Clay	1,300 to 1,700
Shallow to Gravel	1,300 to 1,700
Shallow	1,200 to 1,600
Panspots	1,200 to 1,600
Dense Clay	1,100 to 1,600
Thin Breaks, 15 to 19 inches precipitation	1,100 to 1,600
Very Shallow	700 to 1,100
Shale	400 to 700
Silty, 20 to 24 inches precipitation	2,500 to 3,000
Clayey, 20 to 24 inches precipitation	2,400 to 2,800
Thin Breaks, 20 to 24 inches precipitation	1,500 to 2,000

Management practices

If range management is to be sound, the stocking rate for grazing animals should be adjusted from season to season according to the amount of forage produced. In addition to the main range, reserve pasture and other feed should be provided during droughts and other periods when little forage grows. In this way, it is not necessary for the range to be more than moderately grazed at any time. The rancher can help balance livestock production with forage production, and yet not sell his breeder animals, by keeping some of his stocker steers and other livestock ready for sale.

Two general practices of management that maintain and improve the range, and are economical to use, are proper use and deferred grazing.

Under *proper use*, grazing is at a rate that permits plants to maintain their vigor, that provides needed forage reserves, and that leaves enough residue to control loss of soils and water. In addition, this practice may improve the composition of range in poor condition.

Livestock graze selectively, always seeking the more palatable and nutritious plants. If grazing is too close, the more palatable, taller kinds of plants are weakened and are later eliminated from the original mixture. The less palatable, second-choice plants then increase, but forage yields are lower, and plants give less protection against erosion. If grazing continues, the second-choice plants are eliminated, and undesirable weeds and invaders take their place.

Under *deferred grazing*, the range is rested by keeping off livestock for a definite period during the growing season. This practice increases the vigor of the forage and permits the desirable plants to reproduce naturally. In addition, deferred grazing builds up a forage reserve that can be used later.

In carrying out either of the two general practices described, range can be improved by seeding, providing water in good locations, fencing, salting, controlling brush, and providing supplemental feed.

Seeding.—Native grasses, either wild or improved, are suitable for seeding or reseeding a deteriorated range. The seeded range should have climate and soils that naturally support the range plants without any management other than controlling grazing. A mixture of grasses that are dominant in the range site and are locally adapted should be seeded. If native grasses are used, the seed planted should be produced no farther away than 150 miles south or 200 miles north.

Water.—Watering places should be established throughout the entire range so that grazing animals do not have far to go for water. Good distribution of water helps to achieve uniform use of the range. In the survey area water is generally supplied by ponds, wells, springs, and seeps. The type of watering place developed depends on the kind of source available.

Fencing.—Fences should be erected so that grazing can be controlled. Distribution of grazing is improved by erecting cross fences in large areas. Because water is available for only a limited time, pastures should be separated so that they can be used seasonally. If an area of a range site is large enough, it should be fenced as a grazing unit because its climax grasses differ from those of adjacent range sites.

Salting.—Salting has been called the cheap cowboy because the proper placement of salt is a good tool for obtaining uniform grazing. Generally, the salt should be placed where the forage is good, but away from water or other areas where livestock tend to concentrate. After the forage near the salt has been sufficiently grazed, the salt should be moved to another place where forage is good, for this helps obtain proper use of range.

Controlling brush.—Applying chemicals, particularly on big sagebrush, may be needed in some areas to control brush and thereby improve forage and make the handling of livestock easier.

Supplemental feed.—In addition to the forage on the range, the grazing animals may need hay or tame pasture, harvested roughage, and supplemental concentrates to keep them in good condition throughout the year. During emergencies, the use of roughage reserved for feed and the grazing of deferred areas indirectly conserve plant cover, soil, and water on the entire range. The reserves are in addition to the normal winter requirements. Feed shortages can be avoided by reserving the surplus produced in years of high yields.

Use of Soils as Woodland and in Windbreaks [4]

This subsection describes the natural woodland in the Judith Basin Area, discusses its woodland suitability groups of soils, and gives data on yields of lodgepole and ponderosa pine. It also discusses windbreaks and describes the windbreak suitability groups in the survey area.

Natural woodland

Natural woodland makes up about 3.2 percent of the Judith Basin Area, or approximately 32,300 acres. It consists of about 23,000 acres of privately owned commercial forest along the fringes of the foothills, about 9,200 acres of national forest in the Highwood Mountains, and a small tract of national forest on the northeastern front of the Little Belt Mountains.

The principal trees are lodgepole pine and Douglas-fir, which occur in about equal amounts. Areas that are mainly in ponderosa pine are much less extensive and make up about 15 percent of the commercial forest. About 1 percent of the commercial forest is in cottonwood, which occurs along some of the major streams. The areas forested mainly with lodgepole pine, Douglas-fir, ponderosa pine, or cottonwood contain trees of other species, as Engelmann spruce, Alpine fir, whitebark pine, limber pine, Rocky Mountain juniper, creeping juniper, and quaking aspen.

[4] By L. S. MATTHEW, woodland conservationist, Soil Conservation Service.

The woodland stands in the survey area are relatively young. They have been a source of fenceposts, poles, and building logs that are used locally. Recently the use of small logs has increased, especially lodgepole pine for saw timber, pulpwood, and transmission poles.

In addition to yielding wood products, the soils of the woodland store water, aid in regulating streamflow, and take in water that replenishes the underground supply. Trees and litter on the steep slopes protect the soils from water erosion and are valuable for wildlife and recreation. The value of the woodland as range varies with accessibility, density of the trees, and abundance of palatable forage plants.

Woodland suitability groups

To assist in planning the management of woodland, the soils in the survey area that are used mostly to produce wood products have been placed in three woodland suitability groups. These groupings are shown in table 4 and are described in the text. Each group is made up of soils that produce similar kinds and amounts of wood crops and that require similar management.

For each woodland suitability group, table 4 lists the site index for lodgepole pine, ponderosa pine, and Douglas-fir. It also rates the limitations and hazards that affect management of each group in order of their priority, and lists the trees that should be favored in management. Some terms used in table 4 require explanation.

The *site index* indicates productivity. It expresses the average height of the taller trees in a stand at a specified age. In table 4, the site index is the height in feet at 100 years of age for ponderosa pine and Douglas-fir and at 80 years for lodgepole pine.

Seedling mortality.—Even when healthy seedlings of a suitable tree are correctly planted, or occur naturally in adequate numbers, some of them will not survive if characteristics of the soil are unfavorable.

Mortality is *slight* if not more than 25 percent of the planted seedlings die, or if trees ordinarily regenerate naturally in places where there are enough seeds. It is *moderate* if 25 or 50 percent of the seedlings die or if trees

TABLE 4.—*Woodland suitability groups of soils*

Group	Soil series and map symbols	Site index [1]			Seedling mortality	Plant competition	Equipment limitation	Windthrow hazard	Erosion hazard	Species priority
		Lodgepole pine	Ponderosa pine	Douglas-fir						
1	Loberg (Lr, Ls). Sapphire (Sb, Sc, Ls).	55–65	55–65	[2]	Slight	Moderate	Moderate	Moderate	Slight or moderate.	Lodgepole pine and Douglas-fir.
2	Hughesville (Hu, St).	40–50	50–60	50–60	Slight	Slight	Moderate	Moderate	Moderate or severe.	Ponderosa pine, lodgepole pine, and Douglas-fir.
3	Cowood (Cw, Cx).	[3] 40–50	[2]	[2]	Slight	Slight	Moderate or severe.	Moderate or severe.	Moderate or severe.	Lodgepole pine and Douglas-fir.

[1] Site index for lodgepole pine is for trees 80 years old; that for ponderosa pine and Douglas-fir is for trees 100 years old.

[2] Data not available.

[3] Data estimated from limited observations.

do not regenerate naturally in numbers needed for adequate restocking. In some places replanting to fill open spaces will be necessary. Mortality is *severe* if more than 50 percent of the planted seedlings die, or if trees do not ordinarily reseed naturally in places where there are enough seeds. If mortality is severe, plant the seedlings where the seeds do not grow, prepare special seedbeds, and use good methods of planting to insure a full stand of trees.

Plant competition.—When a woodland is disturbed by fire, cutting, grazing, or some other means, undesirable brush, trees, and plants may invade. The invading growth competes with the desirable trees and hinders their establishment and growth.

Competition is *slight* if undesirable plants are no special problem. It is *moderate* if the invaders delay but do not prevent the establishment of a normal, fully stocked stand. Where plant competition is moderate, seedbed preparation is generally not needed and simple methods can be used to prevent undesirable plants from invading. Competition is *severe* if trees cannot regenerate naturally. Where competition is severe, carefully prepare the site and use management that includes controlled burning, spraying with chemicals, and girdling.

Equipment limitation.—Drainage, slope, stoniness, soil texture, and other soil characteristics may restrict the use of ordinary equipment in pruning, thinning, harvesting, or other woodland management. Different soils may require different kinds of equipment, methods of operation, or seasons when the equipment can be used.

Limitation is *slight* if there are no restrictions on the type of equipment or the time of year that the equipment can be used. It is *moderate* if slopes are moderately steep, if heavy equipment is restricted by wetness in winter and early in spring, or if the use of equipment damages the tree roots to some extent. Equipment limitation is severe if many types of equipment cannot be used, if the time equipment cannot be used is more than 3 months a year, and if the use of equipment severely damages the roots of trees and the structure and stability of the soil. Limitation is severe on moderately steep and steep soils that are stony and have rock outcrops. It is also severe on wet bottom lands and low terraces in winter or early in spring.

Windthrow hazard.—Soil characteristics affect the development of tree roots and the firmness with which the roots anchor the trees in the soil so that they resist the force of the wind. Root development may be prevented by a high water table or by an impermeable layer. The protection of surrounding trees also affects windthrow hazard. Knowing the degree of this hazard is important when choosing trees for planting and when planning release cuttings or harvest cuttings.

The windthrow hazard is *slight* if roots hold the tree firmly against a normal wind. Individual trees are likely to remain standing if protective trees on all sides are removed. The hazard is *moderate* if the roots develop enough to hold the tree firmly except when the soil is excessively wet and the wind velocity is very high. It is *severe* if rooting is not deep enough to give adequate stability. Individual trees are likely to be blown over if they are released on all sides.

Erosion hazard.—Woodland can be protected from erosion by choosing the kinds of trees, by adjusting the rotation age and cutting cycles, by using special techniques in management, and by carefully constructing and maintaining roads, trails, and landings.

Erosion hazard is rated according to the risk of erosion on well-managed woodland that is not protected by special practices. It is *slight* where a small loss of soil is expected. Generally, erosion is slight if slopes range from 0 to 2 percent and runoff is slow or very slow. The erosion hazard is *moderate* where there would be a moderate loss of soil if runoff is not controlled and the plant cover is not adequate for protection. It is *severe* where steep slopes, rapid runoff, slow infiltration and permeability, and past erosion make the soil susceptible to severe erosion.

Management by woodland suitability groups

Only the soils of the Loberg, Sapphire, Hughesville, and Cowood series have been placed in woodland suitability groups, for in the survey area only these soils are important as woodland. These soils have a total area of about 24,000 acres and amount to about 3 percent of the survey area. They have been placed in three woodland suitability groups, which are discussed on the following pages.

WOODLAND SUITABILITY GROUP 1

This group consists of Loberg and Sapphire soils. The Sapphire soils developed in material weathered from sandstone, and the Loberg soils in material weathered from varying mixtures of shale, sandstone, and igneous rock. All the soils in this group are moderately deep. They take in water readily and have good moisture-holding capacity. Intricately intermingled in some places, but not shown separately on the soil map, are Woodhurst soils with the Loberg soils and Cheadle soils with the Sapphire soils. The Woodhurst and Cheadle are grassland soils. The soils in this group are—

Loberg stony loam.
Loberg-Sapphire complex.
Sapphire soils.
Sapphire-Cheadle complex (Sapphire part).

Lodgepole pine is the predominant tree in this woodland group. According to measurements on individual plots, the site index for lodgepole pine on the soils of this group ranges from 55 to 65.

If seed is available, trees on this group ordinarily reseed naturally. After an area is logged, the spread of seed is expected to be good. Germination is best in areas that receive full sunlight. Dense stands that tend to stagnate at an early age are common, and the stagnation is difficult to prevent unless the stands are thinned when the trees are young.

The stands of lodgepole pine are generally dense enough to prevent serious competition from other plants. In the understory are scattered individual or small groups of Douglas-fir, but these do not interfere with the growth of the pine. Woody shrubs are common in the understory, but they compete only slightly with the lodgepole pine.

Windthrow may be a hazard in exposed places because the wind is high at times. Nevertheless, the soils of this group favor deep rooting, which counteracts windthrow. Damage from the breaking of branches by wind or snow is as common as uprooting. Because damage from snow increases when a stand is opened, care should be taken in regulating the space between trees.

Limitations to the use of equipment is moderate. The topography is not rough enough to make the use of equipment difficult. Slopes are firm except when they are wet. The soil texture hinders the use of equipment only in wet periods. Although some areas are stony, the stones do not interfere with logging.

The hazard of erosion is generally slight, but it may be moderate in areas where the protective cover has been removed. Care is needed in locating and maintaining roads, trails, and logging landings.

Problems of disease and of insects and other pests cannot be related to the soils of this group.

Some areas of these soils are used as range, but the Loberg and Sapphire soils have not been placed in range sites. Most of the forage for livestock is produced in areas that are near forested areas. Trees may invade the grassland in some places if the competition from the grass is low because of overgrazing.

WOODLAND SUITABILITY GROUP 2

Only the Hughesville part of the Hughesville-Duncom and Skaggs-Duncom-Hughesville complexes is in this woodland suitability group. These Hughesville soils occur in the Little Belt Mountains. They are thin and generally stony, but they developed in moderately deep loam and clay loam. These soils take in water fairly well and have good moisture-holding capacity. Intricately intermingled with these soils in some places, but not shown separately on the soil map, are Skaggs soils, as well as Duncom soils. The Duncom and Skaggs are grassland soils.

According to measurements on individual plots, Hughesville soils have a site index of 40 to 50 for lodgepole pine and 50 to 60 for ponderosa pine and Douglas-fir. Most of the Douglas-fir stands in the survey area are on Hughesville soils.

Seedling mortality is not a problem on the soils of this group. Stands are ordinarily reestablished through natural seeding if enough seed is available. Competition from other plants is slight.

Windthrow occurs only occasionally, and then only in exposed areas. Stands of ponderosa pine and Douglas-fir can be thinned and logged without risking loss from wind. The stands of lodgepole pine, however, may be damaged by snow and wind if they are opened up too much through thinning.

Limitations to the use of equipment are moderate and are caused by the steep slopes and by wetness in some periods.

The erosion hazard is moderate or severe and is a result of the steep slopes and intense local showers. Care is needed in locating and maintaining roads, trails, and logging landings.

Problems of disease and of insects and other pests cannot be related to the soils of this group.

Some areas of these soils are grazed but the Hughesville soils have not been placed in a range site. The growth in areas of ponderosa pine includes grasses and other plants that have some value for grazing. The value of the forage is less in areas of lodgepole pine and Douglas-fir because the tree stands are dense. The trees in this range site may invade the adjoining grassland when conditions favor the seedlings and competition from the grass is low because of overgrazing or other causes.

WOODLAND SUITABILITY GROUP 3

Only Cowood stony loam and the Cowood soils in the Cowood-Rock outcrop complex are in this capability unit. These soils are mainly stony loam and gravelly loam, but small areas of loam and silt loam also occur. The Cowood soils are on very steep slopes and in rugged areas of the Highwood Mountains. They developed in gravelly and loamy material that weathered from igneous rock. These soils are porous and highly permeable. They take in water readily but have only fair or low moisture-storage capacity.

The productivity of trees on Cowood soils is low or moderate. The site index for lodgepole pine ranges from 40 to 50. Areas of these soils are more valuable as watersheds or for other purposes than they are for their wood products. The better stands of lodgepole pine are in more or less isolated thickets on north slopes and along drainageways.

Seedling mortality is not a problem on Cowood soils. Wooded areas can be expected to restock satisfactorily by natural reseeding.

Competition from other plants is slight. Because lodgepole pine can generally reestablish dense stands, other plants do not encroach on it.

Limitations to the use of equipment are moderate or severe, chiefly because the topography is rugged and bedrock crops out extensively. Cowood soils can be used throughout most seasons, but forestry operations are limited when the soils are saturated.

The hazard of erosion is moderate or severe. The Cowood soils are susceptible to erosion partly because their surface layer is sandy and has weak structure.

Yields of lodgepole pine and ponderosa pine

Table 5 lists, by age and site index, yield information for well-stocked, normally growing, unmanaged stands of lodgepole pine. The table is based on British of Columbia Forest Service studies (*3*).[5] Table 6 is a similar table with yield information for ponderosa pine. It is based on the U.S. Department of Agriculture Technical Bulletin 630 (*8*). From these tables, average yields and other information for a specified age and site index can be determined and future yields can be predicted.

In table 5, for example, a stand of lodgepole pine 80 years old that is on a soil having a site index of 60 would have 3,400 cubic feet of wood per acre in trees 6 inches or more in diameter. By using the conversion factors at the bottom of the table, it is seen that this volume amounts to approximately 37 cords or 20,000 board feet. To predict the yield of this stand in 20 years, refer to site index of 60 and age of 100 years. The total volume is 4,600 cubic feet, or an increase of 1,200 cubic feet. The stand, therefore, had an average increase of 60 feet annually. This is approximately double the increase in volume, for the same period, on a stand of the same age that is on a soil with a site index of 40.

[5] Italicized numbers in parentheses refer to Literature Cited p. 153.

TABLE 5.—*Stand and yield information for a well-stocked, unmanaged, natural stand of lodgepole pine*

[Based on studies of the British of Columbia Forest Service (*3*)]

Site index	Age	Volume per acre of trees 6 inches or more in diameter [1]	Average height of dominant and codominant trees	Average diameter of trees 6 inches or more in diameter	Trees 6 inches or more in diameter per acre
	Year	*Cubic feet*	*Feet*	*Inches*	*Number*
40	20		12		
	30		18		
	40	76	25	6.0	28
	50	400	30	6.4	114
	60	835	34	6.9	180
	70	1,250	37	7.1	235
	80	1,710	40	7.3	288
	90	2,100	42	7.5	330
	100	2,400	44	7.7	350
	110	2,700	45	7.8	352
	120	2,900	46	7.9	366
50	20		15		
	30		23		
	40	200	31	6.1	54
	50	630	37	6.6	152
	60	1,220	42	7.0	220
	70	1,790	47	7.3	280
	80	2,350	50	7.5	330
	90	2,840	52	7.8	366
	100	3,230	54	8.0	380
	110	3,600	56	8.2	385
	120	3,850	57	8.3	388
60	20		18		
	30		27		
	40	410	37	6.1	108
	50	1,150	45	6.8	200
	60	2,000	51	7.2	285
	70	2,700	56	7.6	337
	80	3,400	60	7.9	370
	90	4,060	63	8.2	387
	100	4,600	65	8.3	394
	110	5,130	67	8.6	396
	120	5,600	68	8.7	398
70	20		21		
	30	148	32	6.0	40
	40	945	43	6.6	160
	50	2,050	53	7.2	278
	60	3,150	60	7.7	354
	70	4,220	65	8.0	384
	80	5,200	70	8.4	394
	90	5,920	74	8.7	394
	100	6,520	77	9.0	390
	110	7,000	79	9.3	382
	120	7,400	80	9.5	374

[1] Divide by 90 to convert to approximate cords; multiply by 6 to convert to approximate board feet.

TABLE 6.—*Stand and yield information for a well-stocked, even-aged, unmanaged, natural stand of ponderosa pine* [1]

[Based on U.S. Department of Agriculture Bulletin 630 (*8*)]

Site index	Age	Volume per acre of trees 6.6 inches or more in diameter [2]	Volume per acre of trees 11.6 inches or more in diameter (Scribner)	Average height of dominant and codominant trees	Average diameter of trees 6.6 inches or more in diameter	Trees 6.6 inches or more in diameter per acre
	Year	*Cubic feet*	*Board feet*	*Feet*	*Inches*	*Number*
50	20			9		
	30			15		
	40	80		22	7.3	21
	50	280		28	7.5	72
	60	640		34	7.8	126
	70	1,130	300	39	8.2	190
	80	1,640	900	43	8.5	236
	90	2,100	2,000	47	8.9	252
	100	2,500	3,400	50	9.3	256
	110	2,850	5,000	53	9.8	250
	120	3,150	7,000	55	10.3	237
	130	3,400	8,900	57	10.8	224
	140	3,600	10,700	59	11.2	212
	150	3,770	12,400	60	11.6	200
60	20			12		
	30	50		20	7.2	11
	40	310		28	7.5	66
	50	820	100	35	7.8	154
	60	1,450	600	42	8.2	218
	70	2,080	1,800	47	8.6	260
	80	2,650	3,500	52	9.1	280
	90	3,150	5,500	57	9.7	274
	100	3,570	7,800	60	10.3	259
	110	3,930	10,200	63	10.9	240
	120	4,240	12,500	66	11.5	222
	130	4,500	14,700	69	12.1	205
	140	4,710	16,700	71	12.7	188
	150	4,890	18,500	73	13.2	175
70	20			16		
	30	210		26	7.5	47
	40	720	100	35	7.9	151
	50	1,480	700	43	8.3	254
	60	2,220	2,200	50	8.8	296
	70	2,920	4,300	56	9.4	303
	80	3,530	7,000	61	10.0	292
	90	4,050	10,000	66	10.6	272
	100	4,480	13,100	70	11.3	246
	110	4,850	16,200	74	12.0	224
	120	5,170	19,000	77	12.7	202
	130	5,440	21,500	80	13.4	185
	140	5,670	23,700	83	14.0	170
	150	5,870	25,700	86	14.6	157

[1] Data in this table can also be used for Douglas-fir.
[2] Divide by 90 to convert to approximate cords; multiply by 6 to convert to approximate board feet.

Windbreaks

A well-placed windbreak with properly spaced trees protects farmsteads, fields, livestock, and wildlife from wind and snow. It controls snow drifts by reducing the velocity of the wind. In addition to the protection it gives, a well-tended windbreak is attractive and improves the esthetic setting of farm and ranch buildings.

The trees growing in the Judith Basin Area indicate that plantings can be established on nearly every farm and ranch. Exceptions are on soils that are shallow, saline or alkali, very poorly drained, steep, or very stony. Few farmsteads, however, are built on soils having these adverse characteristics.

Experimental work in tree planting was started at the Judith Basin Branch Experiment Station near Moccasin in 1912. The first windbreak was planted to protect farmsteads and other buildings. Tests of the effects of various management practices were started in the spring of 1918. These tests included experiments to determine adaptability of species, spacing distances, pruning methods, the response to cultivation, the effect of mulching and rates of growth (*5*).

Trial plantings at the branch experiment station and plantings on farms have shown that Caragana, green ash, Russian-olive, and American elm are especially suitable for dryland plantings. Boxelder has not been satisfactory. Siberian (Chinese) elm grows rapidly and provides early protection, but in older plantings the crowns sometimes become ragged because of light to moderate winterkilling. Caragana is the most widely planted shrub and is outstanding when used for the windward row, for a large percentage of these planted shrubs survive and produce dense rows. Tatarian honeysuckle, chokecherry, and American plum are planted less extensively than Caragana, but they also grow well.

Cottonwood and willow are fast growing, but in dryland plantings they live only 12 to 15 years unless the supply of moisture is adequate. These trees are vigorous for many years on wet upland swales and slopes or in areas that have a beneficial water table. They are suited to the Fergus, Savage, Straw, Gallatin, or other soils that have a good natural supply of moisture (fig. 14).

Evergreens are best for year-round protection. They are generally more difficult to start than the broad-leaved trees, but growth is fairly fast after they are established. Ponderosa pine, white spruce, and Colorado blue spruce are most commonly planted, but Rocky Mountain juniper should do better than spruce on the Castle, Pierre, Promise, Terrad, and other fine-textured soils, or on Utica, Ashuelot, and other limy soils. Trial plantings of evergreens at the Judith Basin Station indicate an average annual growth of 9 inches through a 20-year period. The maximum increase in height for any one year was 17 inches. The spruce trees differed little in final height.

Trial plantings were made at the Judith Basin Station on Danvers and Judith soils, which are extensive in the survey area. Growth on these and similar soils is generally uniform, except that trees are somewhat shorter in shallow spots. The estimated height of trees and shrubs 5 and 10 years old are shown in table 7. The height of the trees and shrubs varies according to the soil, the slope, cultivation, injury, moisture available, competition from other plants, and other factors.

TABLE 7.—*Estimated height of trees and shrubs on Danvers-Judith clay loams where precipitation is normal*

Tree or shrub	Height in 5 years	Height in 10 years
	Feet	*Feet*
Tree:		
American elm	5	10
Boxelder	7	10
Colorado (blue) spruce	3	5
Cottonwood [1]	12	18
Green ash	5	10
Ponderosa pine	3	5
Rocky Mountain juniper	2	4
Russian-olive	6	8
Siberian (Chinese) elm	8	12
White (Black Hills) spruce	3	5
Willows [1]	10	14
Shrub:		
American plum	5	7
Caragana	4	6
Chokecherry	5	8
Silver buffaloberry	5	7
Tatarian honeysuckle	4	6

[1] Suitable only for irrigated areas or for areas with a beneficial water table.

Clean cultivation is needed for the successful establishment of trees in windbreaks. In older, well-established plantings, trees in deep soils having an adequate supply of moisture apparently retain their vigor when competing with grass and other vegetation, but plantings depending on normal precipitation alone soon deteriorate if they are not cultivated (fig. 15).

Mulch is not satisfactory as a substitute for cultivation, but it may be needed to control erosion. The mulch harbors rodents that may girdle the trees, and it is a fire hazard.

Pruning reduces the effectiveness of a windbreak. Trees with their lower branches removed make a poor wind barrier. Pruning is beneficial only for encouraging the development of single stems, for correcting weak branching, and for removing broken branches.

drained, but the trees send their roots down to moisture. (Photograph courtesy of Calder's Exclusive Aerial Murals, Lewistown, Mont.)

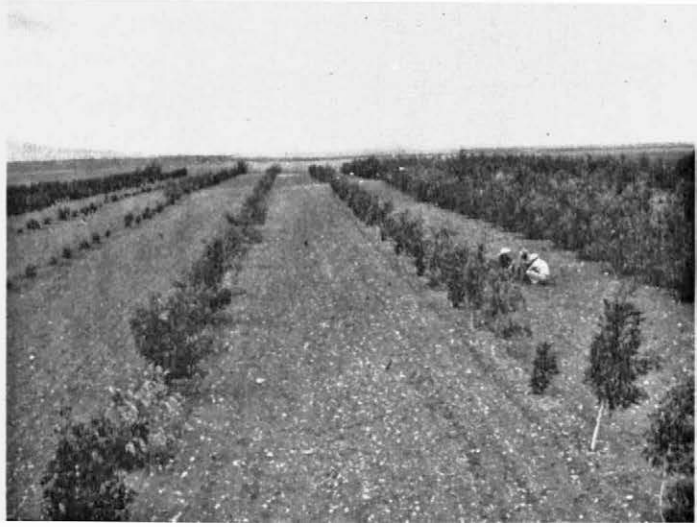

***Figure 15.*—Young trees that were planted on Danvers gravelly clay loam. Clean tillage is a big factor in successful tree planting on soils with a small amount of moisture.**

If livestock can get to the plantings, they injure them and also compact the soils by trampling. Their browsing and breaking of lower branches reduce effectiveness where it is needed most.

The four kinds of insects that damage trees are (1) leaf-eating insects like blister beetles, caterpillars, and canker-worms; (2) sucking insects, including aphids that are common on American elm; (3) borers that tunnel into trunks and branches; and (4) scale insects. Trees kept in vigorous condition are less susceptible to insects and diseases than trees that have been weakened by drought or neglect.

Rabbits are one of the major pests that damage tree plantings. They damage the young plants by cutting stems and branches and by peeling the bark. Pocket gophers eat tree roots, and field mice may girdle or strip the bark from trees during winter.

Further information or direct assistance in planning and care of windbreaks is available from the Soil Conservation Service and the Extension Service.

Windbreak suitability groups

The kind of soil largely determines the most suitable trees and shrubs for windbreaks, their growth, and the management needed for their upkeep. Most trees and shrubs are not tolerant of saline and alkaline soils. They are better suited to medium-textured soils than to fine-textured soils. Most of them grow best in deep, well-drained soils that have good moisture-storage capacity, but willow and cottonwood do well on imperfectly drained to poorly drained soils. Tree roots need aeration, the roots of some trees more than others.

Many soils in the survey area are not suitable for trees and shrubs in windbreaks because the slopes are steep, stones are numerous, the soils are very shallow, drainage is poor or very poor, or the salt content is high. These soils have a total area of about 358,000 acres, and they amount to about 40 percent of the survey area.

The rest of the soils in the survey area are placed in 10 windbreak suitability groups on the basis of their suitability for trees and shrubs and the management needed. In the discussion of each group is a general description of the soils in the group, a list of soils that make up the group, and general statements about the management of these soils.

Because the soils in some complexes do not have the same suitability for trees and shrubs, only parts of complexes have been placed in some windbreak suitability groups. Parts of complexes, of course, are not shown on the soil map. The user of this report can learn how to distinguish the parts of complexes by referring to the complexes in the section "Descriptions of the Soils."

WINDBREAK SUITABILITY GROUP 1

The soils in this group are the most desirable in the county for trees and shrubs in windbreaks. The group consists of deep, well-drained, dark-brown to black soils that have a loam or light clay loam subsoil and occupy stream terraces and fans on slopes of not more than 8 percent. These soils take in water readily and have good moisture-storage capacity. They are deep enough to anchor the roots of deep-rooted trees. The soils are—

- Ak Adel loam, 2 to 8 percent slopes.
- Am Adel silt loam, terrace.
- Bp Bridger loam, 2 to 4 percent slopes.
- Ra Raynesford and Adel loams, 2 to 4 percent slopes (Adel part).
- Rd Raynesford and Adel loams, 4 to 8 percent slopes (Adel part).
- Sw Straw clay loam, 0 to 2 percent slopes.
- Sx Straw clay loam, 2 to 4 percent slopes.
- To Twin Creek loam, 2 to 4 percent slopes.
- Tp Twin Creek loam, 4 to 8 percent slopes.
- Tw Twin Creek clay loam, 0 to 2 percent slopes.

Identifying the single soils in the Raynesford and Adel loams may be more difficult than identifying the other soils in this group, which are shown separately on the soil map. The Raynesford soils occur in convex positions on fans, and the Adel soils occur in concave positions and lower parts of some of the same fans. The Raynesford soils have a light-colored, strongly calcareous subsoil within 16 inches of the surface, but the Adel soils are deep to lime, which is in smaller quantities than that in the Raynesford soils.

Because the soils in this group are well suited to trees and shrubs in windbreaks, only ordinary management, without special practices, is needed.

WINDBREAK SUITABILITY GROUP 2

This group consists of soils that are steeper than those in windbreak group 1. These soils are suited to the same kinds of trees, but the steeper slopes increase the hazard of erosion. The soils are—

- Al Adel loam, 8 to 18 percent slopes.
- Br Bridger loam, 4 to 15 percent slopes.
- Rf Raynesford and Adel loams, 8 to 15 percent slopes (Adel part).
- Tr Twin Creek loam, 8 to 15 percent slopes.

The Raynesford loam generally occurs in convex positions on fans, and the Adel loam occurs in concave areas. The Raynesford soil can be identified by its light-colored, strongly calcareous subsoil. The Adel soil is deeper to lime than the Raynesford soil, and the lime occurs in smaller quantities.

The loss of soil and water from the soils of this group can be lessened by planting and cultivating trees on the contour.

WINDBREAK SUITABILITY GROUP 3

This group consists of soils that have a surface layer of clay loam, gravelly clay loam, or cobbly clay loam and a subsoil of clay loam or light clay loam. Most of these soils are on high benches, stream terraces, and fans. Slopes generally are less than 8 percent. Because of the clay loam and light clay loam subsoil, the soils in this group are slightly less desirable for windbreaks than the soils in groups 1 and 2. They are—

- Bd Beckton-Danvers clay loams (Danvers part).
- Da Danvers clay loam, 0 to 2 percent slopes.
- Db Danvers clay loam, 2 to 4 percent slopes.
- Dc Danvers clay loam, 4 to 8 percent slopes.
- Dd Danvers cobbly clay loam, 0 to 4 percent slopes.
- Df Danvers cobbly clay loam, 4 to 8 percent slopes.
- Dg Danvers cobbly clay loam, 8 to 15 percent slopes.
- Dh Danvers gravelly clay loam, 0 to 4 percent slopes.
- Dm Danvers-Judith clay loams, 0 to 2 percent slopes (Danvers part).
- Dn Danvers-Judith clay loams, 2 to 4 percent slopes (Danvers part).
- Do Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes (Danvers part).
- Dp Danvers-Judith gravelly clay loams, 0 to 2 percent slopes (Danvers part).

Fc Fergus clay loam, 0 to 2 percent slopes.
Fd Fergus clay loam, 2 to 4 percent slopes.
Ff Fergus clay loam, 4 to 8 percent slopes.
Fh Fergus clay loam, 8 to 15 percent slopes.
Jp Judith-Danvers gravelly clay loams, 0 to 4 percent slopes (Danvers part).
Jt Judith and Savage soils (Savage part).
Sg Savage silty clay loam, 0 to 2 percent slopes.
Sh Savage silty clay loam, 2 to 4 percent slopes.
Sk Savage silty clay loam, 4 to 8 percent slopes.
Wb Winifred clay loam, 0 to 4 percent slopes.
Wc Winifred clay loam, 4 to 8 percent slopes.
Wd Winifred clay loam, 8 to 15 percent slopes.
Wf Winifred cobbly clay loam, 2 to 8 percent slopes.
Wh Winifred cobbly clay loam, 8 to 15 percent slopes.
Wk Winifred-Judith clay loams.
Wm Winifred-Rhoades clay loams (Winifred part).

For the complexes and undifferentiated soil groups in the foregoing list see the section "Descriptions of the Soils." These descriptions help identify the soils in the field and tell how much of each kind of soil is in the mapping unit.

Most areas of Fergus and Savage soils on the lower terraces contain moisture that deep-rooted trees and shrubs can reach.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep loams, a clay loam, and Wet land. These soils occur on bottom lands and have a water table at a depth generally ranging from 2½ to 6 feet. The soils are—

Ga Gallatin clay loam.
Gb Gallatin loam.
Su Slocum loam.
Wa Wet land.

Most shrubs and trees, particularly willows, grow satisfactorily on these soils. In many places Wet land is too wet for trees and shrubs, but in some places the content of moisture is just right for some of the more tolerant species.

WINDBREAK SUITABILITY GROUP 5

This group consists of soils that have a loam, channery loam, channery clay loam, clay loam, or silty clay loam surface layer. The subsoil is clay loam or light clay loam that is underlain by shale or sandstone at a depth of 20 to 36 inches. These soils occur on rolling uplands that have slopes of not more than 15 percent. They are not so deep as the soils in windbreak suitability group 1 and do not permit as much storage of water or as deep penetration of roots. The soils are—

Aa Absarokee clay loam, 2 to 8 percent slopes.
Ab Absarokee clay loam, 8 to 15 percent slopes.
Ad Absarokee-Cheadle channery loams, 2 to 8 percent slopes (Absarokee part).
Af Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded (Absarokee part).
Ah Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes (Absarokee part).
An Alder clay loam, 2 to 8 percent slopes.
Ao Alder clay loam, 8 to 15 percent slopes.
Ar Alder-Maginnis channery clay loams, 2 to 8 percent slopes (Alder part).
Bg Blaine-Spring Creek loams, 2 to 8 percent slopes (Blaine part).
Cd Chama clay loam, 4 to 8 percent slopes.
Cf Chama-Midway clay loams, 4 to 8 percent slopes (Chama part).
Cg Chama-Midway clay loams, 8 to 15 percent slopes (Chama part).
Dr Darret clay loam, 8 to 15 percent slopes.
Dt Darret-Cheadle complex, 2 to 8 percent slopes (Darret part).
Fs Fergus silty clay loam, shale substratum, 2 to 8 percent slopes.
Td Teton loam, 2 to 8 percent slopes.
Tf Teton loam, 8 to 15 percent slopes.
Tk Teton-Cheadle channery loams, 4 to 15 percent slopes (Teton part).

To determine the proportion of each soil in the soil complexes, and to locate a description that will help identify those soils in the field, refer to the section "Descriptions of the Soils."

Trees and shrubs grow well on the soils of this group if planning and care are good. Loss of needed moisture can be lessened by contour planting and clean cultivation. Additional water may be obtained by diverting runoff from higher ground into the windbreaks.

WINDBREAK SUITABILITY GROUP 6

This group consists of loams, clay loams, and gravelly clay loams, that have a layer of lime accumulation at a depth of 10 to 20 inches. These soils occur on high benches, terraces, fans, and uplands on slopes of less than 15 percent. They have good to fair moisture-storage capacity. The soils are—

Dm Danvers-Judith clay loams, 0 to 2 percent slopes (Judith part).
Dn Danvers-Judith clay loams, 2 to 4 percent slopes (Judith part).
Do Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes (Judith part).
Dp Danvers-Judith gravelly clay loams, 0 to 2 percent slopes (Judith part).
Ja Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Judith part).
Jb Judith clay loam, 0 to 2 percent slopes.
Jc Judith clay loam, 2 to 4 percent slopes.
Jd Judith clay loam, 4 to 8 percent slopes.
Jf Judith clay loam, low terrace.
Jh Judith cobbly clay loam, 0 to 4 percent slopes.
Jk Judith cobbly clay loam, low terrace, 0 to 4 percent slopes.
Jl Judith gravelly clay loam, 0 to 2 percent slopes.
Jm Judith gravelly clay loam, 2 to 4 percent slopes.
Jn Judith gravelly clay loam, 4 to 8 percent slopes.
Jo Judith gravelly clay loam, low terrace, 0 to 4 percent slopes.
Jp Judith-Danvers gravelly clay loams, 0 to 4 percent slopes (Judith part).
Jt Judith and Savage soils (Judith part).
Ju Judith-Utica gravelly loams, 4 to 8 percent slopes (Judith part).
Jv Judith-Utica gravelly loams, 8 to 15 percent slopes (Judith part).
Ra Raynesford and Adel loams, 2 to 4 percent slopes (Raynesford part).
Rd Raynesford and Adel loams, 4 to 8 percent slopes (Raynesford part).
Rf Raynesford and Adel loams, 8 to 15 percent slopes (Raynesford part).
Sl Skaggs loam.
Sm Skaggs clay loam, 4 to 8 percent slopes.
Sn Skaggs clay loam, 8 to 15 percent slopes.
Sy Straw clay loam, gravelly substratum.
Ug Utica-Judith gravelly loams, sandy substratum (Judith part).

To determine the proportion of each soil in the complexes and undifferentiated groups in the foregoing list, and to locate a description that will help identify the soils in the field, refer to the section "Descriptions of the Soils."

Because of the lime concentration, roots do not extend deeply into these soils, and trees and shrubs do not grow so tall as those on soils containing less lime and more moisture. Satisfactory windbreaks, however, can be obtained if management is good. Moisture is conserved by plant-

ing on the contour and by clean cultivation. Irrigation improves the windbreaks where it is feasible.

WINDBREAK SUITABILITY GROUP 7

This group consists of soils that have a loam to clay or cobbly clay surface layer and a clay subsoil. The subsoil is underlain by shale at a depth of more than 20 inches. These soils occur on fans, terraces, and rolling uplands on slopes of less than 15 percent. They are slowly permeable. The soils are—

- Ac Absarokee silty clay, 2 to 8 percent slopes.
- Bf Beckton-Savage complex (Savage part).
- Bk Blythe loam, 2 to 4 percent slopes.
- Bm Blythe loam, 4 to 8 percent slopes.
- Ca Castle clay, 4 to 15 percent slopes.
- Pc Pierre clay, 2 to 8 percent slopes.
- Pm Promise clay, 0 to 2 percent slopes.
- Po Promise clay, 2 to 8 percent slopes.
- Pp Promise clay, 8 to 15 percent slopes.
- Pr Promise cobbly clay.
- Sd Savage silty clay, 0 to 2 percent slopes.
- Se Savage silty clay, 2 to 4 percent slopes.
- Sf Savage silty clay, 4 to 8 percent slopes.
- Ta Terrad clay, 2 to 8 percent slopes.
- Tb Terrad clay, 8 to 35 percent slopes.
- Tc Terrad silty clay, 0 to 2 percent slopes.

To determine the proportion of each soil in the complex in this group, and to locate a description that will help identify the soils in the field, refer to the description of the complex in the section "Descriptions of the Soils."

These soils are not so good for trees as are soils that are more loamy and more permeable. The kinds of trees planted should be selected carefully, and they should be planted on the contour where feasible.

WINDBREAK SUITABILITY GROUP 8

This windbreak group consists of wet and very wet clayey soils. The water table of these soils fluctuates. In some of the soils it is only a few inches from the surface at times, and in others it is as much as 5 feet deep. All of these soils have a calcareous subsoil, and most of them have a calcareous surface layer. The soils are—

- Bo Bowdoin silty clay, low clay variant.
- Cv Colvin-Lamoure clay loams.
- Fa Fargo-Hegne silty clays.
- Gc Gallatin loam, clay substratum.

These soils are suited to only the more water-tolerant trees and shrubs, among them purple willow, buffaloberry, Russian-olive, white willow, golden willow, cottonwood, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 9

This group consists of loams, clay loams, channery loams, and gravelly loams that are less than 20 inches deep to shale, sandstone, or loose pebbles. These soils occur on benches and rolling uplands that have slopes of less than 15 percent. Runoff is medium to rapid. The soils are—

- Ad Absarokee-Cheadle channery loams, 2 to 8 percent slopes (Cheadle part).
- Af Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded (Cheadle part).
- Ah Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes (Maginnis part).
- Ar Alder-Maginnis channery clay loams, 2 to 8 percent slopes (Maginnis part).
- Ax Ashuelot gravelly loam.
- Ba Bainville loam.
- Bg Blaine-Spring Creek loams, 2 to 8 percent slopes (Spring Creek part).
- Cf Chama-Midway clay loams, 4 to 8 percent slopes (Midway part).
- Cg Chama-Midway clay loams, 8 to 15 percent slopes (Midway part).
- Ck Cheadle channery loam, 2 to 8 percent slopes.
- Cm Cheadle channery loam, 8 to 15 percent slopes.
- Cn Cheadle loam, 2 to 8 percent slopes.
- Co Cheadle loam, 8 to 15 percent slopes.
- Dt Darret-Cheadle complex, 2 to 8 percent slopes (Cheadle part).
- Ja Judith-Ashuelot gravelly loams, 0 to 4 percent slopes (Ashuelot part).
- Ju Judith-Utica gravelly loams, 4 to 8 percent slopes (Utica part).
- Tk Teton-Cheadle channery loams, 4 to 15 percent slopes (Cheadle part).
- Ua Utica gravelly loam, 2 to 8 percent slopes.
- Ug Utica-Judith gravelly loams, sandy substratum (Utica part).

To determine the proportion of each soil in the complexes shown in the foregoing list, and to locate a description that will help identify the soils in the field, refer to the section "Descriptions of the Soils."

Because these soils are shallow to bedrock or loose pebbles, roots do not penetrate deeply and trees and shrubs do not grow well.

WINDBREAK SUITABILITY GROUP 10

This group consists of soils that have a claypan or are moderately alkaline in the upper subsoil and saline in the lower. These soils occupy terraces, fans, and, to a lesser extent, rolling uplands. Slopes are less than 8 percent. The intake of water is slow, and runoff is medium to rapid. The soils are—

- At Arvada-Beckton cobbly clay loams.
- Av Arvada-Laurel complex (Arvada part).
- Bb Beckton loam.
- Bc Beckton-Arvada clay loams.
- Bd Beckton-Danvers clay loams (Beckton part).
- Bf Beckton-Savage complex (Beckton part).
- Ro Rhoades-Arvada complex.
- Wm Winifred-Rhoades clay loams (Rhoades part).

Refer to the section "Description of the Soils" to determine the proportion of the soils in each of the four complexes in the foregoing list, and to locate a description that will help identify the soils in the field.

Because of the variable amounts of salts in the subsoil, the growth of roots is not good. Only Caragana, Russian-olive, Siberian elm, Rocky Mountain juniper, and other hardy trees and shrubs grow successfully on the soils of this group.

Wildlife Management [6]

The habitats for wildlife in the Judith Basin Area are in forests, on rangeland, on farmland, and along streams. The Judith River and Dry Wolf Creek are the main streams that attract wildlife. Ackley Lake, an irrigation reservoir, provides good fishing and also attracts wildlife.

The survey area supports several kinds of big game, including elk, deer, and antelope. Native grouse of the uplands are the sharp-tailed, ruffed, spruce, blue, and sage. Gray (Hungarian) partridge and ring-necked pheasants have been introduced and are found on farms.

Many kinds of waterfowl live along the streams of the area. Some farm ponds produce several broods of ducks each year. In the areas near streams and other water,

[6] By L. M. Moos, biologist, Soil Conservation Service.

there are coot, grebe, killdeer, sandpiper, blackbirds, herns, and many other water-loving birds.

The cropland and rangeland provide habitat for mourning doves, meadow larks, horned larks, longspurs, lark buntings, and many other kinds of insectivorous birds. Golden eagles are also found in the survey area. Marsh and sparrow hawks are the most common hawks, but several other kinds live in the area or pass through it during migration.

Also common in the survey area are cottontail and other rabbits, raccoons, ground squirrels, skunks, badgers, porcupines, and other small mammals. Beavers and muskrats live in aquatic places. The upper parts of streams are the home of trout and other cold-water fish.

The number of wildlife in the survey area can be increased by using special practices to improve habitats. Among these practices are the development of odd areas and other areas not used for crops so that they provide food and cover for wildlife. This development includes protection from fire and grazing. Stockwater ponds are fenced so that nesting cover and food for waterfowl and furbearers are undisturbed. Woody vegetation is planted so that winter cover is provided for the wildlife that needs it.

Wildlife is also increased by ordinary conservation practices, including range management, stripcropping, planting field and farm windbreaks (fig. 16), and constructing farm ponds.

Properly constructed farm ponds produce a large amount of trout (fig. 17) and other fish. Although it is not necessary that a pond be fed by a spring, one that is produces the best trout. Cold-water trout are better adapted to most waters in the survey area than warm-water trout.

Figure 16.—Besides protecting farmsteads, windbreaks provide cover for ring-necked pheasants and other game birds.

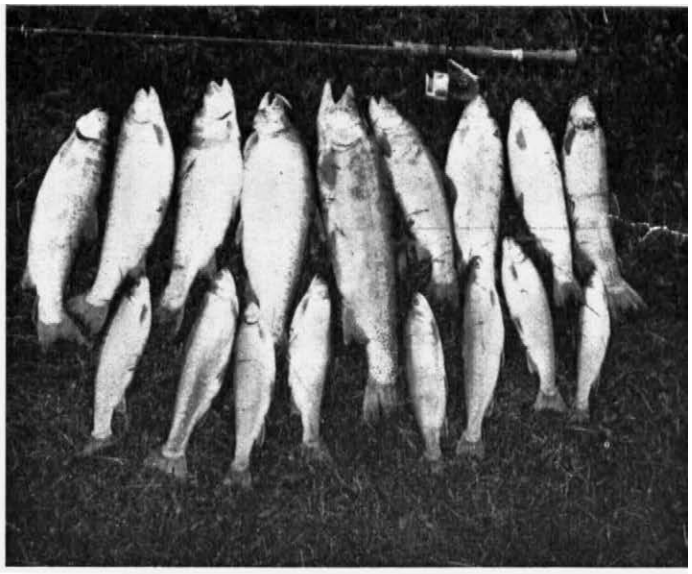

Figure 17.—Trout, 10 to 23 inches in length, that were caught in a 3½-acre spring-fed pond.

Engineering Uses of Soils [7]

This subsection deals with the soils of the survey area from an engineering viewpoint. The section describes two systems of classifying soils for engineering uses, and it gives estimated physical and chemical properties of the soils in the area. Also, it lists data obtained by analyzing soil samples in the laboratory and gives interpretations of soil properties that affect engineering practices and structures.

The engineer uses soil material in construction of roads, foundations for buildings, structures for irrigation and water storage, and structures of other kinds. He is interested in the specific soil properties that determine the suitability of soils as construction material, or that limit their use, in irrigation, drainage, land leveling, disposal of sewage, building sites, and other uses. Some important properties are permeability, bearing strength, stability, susceptibility to frost heave, compaction characteristics, shrink-swell characteristics, water-holding capacity, grain size, plasticity, and soil reaction. Laboratory analysis is required for exact determinations of these properties. Since few soils have been analyzed in the laboratory, the best use must be made of the soil information available. Engineering properties can be estimated by correlating field observations that were made of a soil during the survey with the data from laboratory analysis that are available for other soils. The estimated properties of the soils discussed in this section are based on only a few tested samples.

With the use of the soil map for identification, the engineering interpretations in this subsection can be useful for many purposes. It should be emphasized, however, that they may not eliminate the need for sampling and testing at the site of specific engineering works where loads are heavy and where the evacuations are deeper than the depths of the layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

The information in this report can be used to—

1. Make preliminary estimates of the engineering properties of soils in the general planning for

[7] FRED A. MALLON, civil engineer, Soil Conservation Service, helped prepare this subsection.

agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, or rock for construction use.
4. Aid in selection of industrial, business, residential, and recreational sites.
5. Supplement the information obtained from other published maps, reports, or aerial photographs so that reports that can be used readily by engineers can be prepared.
6. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
7. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer. Other terms may have one meaning to an engineer and another to a soil scientist. In this report such terms are used in their agricultural sense and are so defined in the Glossary.

Much of the information in this subsection is in four tables. Table 8 gives estimates of physical and chemical properties of the soil types in the survey area. Table 9 is a key that lists the soil types in each complex and undifferentiated soil group mapped in the survey area so that the chemical and physical properties of these complexes and groups can be obtained from table 8. Table 10 lists, for selected soils, engineering test data obtained from laboratory analyses, and table 11 is an engineering interpretation of the soils in the survey area.

Systems of soil classification

The three systems of soil classification in table 8—USDA, AASHO, and Unified—require some explanation. Soil scientists and other agricultural workers classify soils according to the system of textural classification used by the Department of Agriculture (USDA). The texture of the soil material made up of particles smaller than 2 millimeters is determined by the percentage of sand, silt, and clay in the soil material.

The other two classifications shown in table 8 are used by engineers. They are the Unified system (*17*) and the system used by the American Association of State Highway Officials (AASHO) (*1*).

The Unified system is based on the identification of soils according to particle size, plasticity, and liquid limit. In this system the soil material is first divided into 3 groups: (1) coarse-grained soils consisting dominantly of gravel and sands; (2) fine-grained soils consisting largely of silts and clays; and (3) highly organic soils. In this survey we are concerned only with coarse-grained and fine-grained soils, for highly organic soils do not occur in the survey area. Furthermore, because none of the materials are classed as sands, this discussion is limited to gravel and fine-grained materials. GW is a mixture of gravel and sand in which the gravel predominates and all material is well graded. Little or no fines occur. GP is also a mixture of gravel and sand in which gravel predominates, but the soil material is said to be poorly graded because the pieces of gravel and the sand are each of one general size. GM is a mixture of gravel, sand, and silt in which gravel makes up more than 50 percent of the coarse material. The sand and silt are each of one general size, and the mixture of the two is nonplastic. ML and CL consist of fine-grained materials that have a low liquid limit; ML is only slightly plastic and CL is moderately plastic. OL consists of organic silts and organic silty clays of low plasticity. CH is made up of inorganic clays that have high plasticity and high liquid limit. These clays are sometimes called fat clays. OH consists of organic clays of medium to high plasticity. For soils on the borderline between two classifications, a dual symbol is used, for example, ML–CL.

The AASHO classification is based on the field performance of materials in highways. In this system soil material is classified according to general load-carrying capacity and service. The 12 basic groups and subgroups in the system are numbered A–1, A–1–a, and so on through A–7. The best soils for road subgrades are classified as A–1, the next best A–2, and the poorest A–7.

Engineering properties of soils

Tables 8 and 9 are provided to give estimated physical and chemical properties of all mapping units in the survey area. In table 8 these estimates are given for all soil types mapped in the survey area, including those mapped only in soil complexes and undifferentiated soil groups. The map symbols of the mapping units included in a soil type are shown in parentheses after the name of that type. By using table 8 alone, the estimated physical and chemical properties can be obtained for any mapping unit that is mapped as a single soil in the survey area.

But tables 8 and 9 are both needed to obtain estimated physical and chemical properties of soil complexes and undifferentiated soil groups. In table 9 the proportion of the main soils in these mapping units are given and, in the last column, the main soil types in these units are listed. By referring to these soil types in table 8, you obtain their chemical and physical properties and, therefore, the physical and chemical properties of the main soils in the complexes and undifferentiated soil groups.

The engineering data in table 10 (p. 104), and the knowledge of the soils that was obtained during the soil survey, were used as a basis for describing the soils in table 8, for estimating their physical properties, and for estimating the percentage of material passing the Nos. 4, 10, and 200 sieves.

In table 8 the estimated ranges in percentage passing sieves Nos. 4, 10, and 200 are average ranges for the soil types. Although most soils in a type have percentages within a range, regardless of where the soils in the type occur, the grain sizes of the soil type vary considerably. Therefore, it should not be assumed that all soils of a given type have percentages that fall within the range shown, nor should it be assumed that the engineering classification is invariably as it is shown in table 8.

Permeability is the rate at which water moves downward through the soil. Permeability in table 8 is given for

a soil in place or relatively undisturbed and was estimated by comparing the soil with soils of known permeability. A range of permeability is given that covers the permeability of the soil type.

As used in this report, available water-holding capacity refers to the inches of water needed to saturate the soil when the content of moisture is at about the lowest point to which growing plants can reduce it. At this point, the amount of water given in table 8 will wet the soil material to a depth of 1 inch but will not penetrate deeper.

Reaction is given as the pH value of the soil. The pH expresses the degree of acidity or alkalinity of the soil and, therefore, indicates how much a pipeline or a similar structure placed in the soil will corrode and how much protection this structure needs.

Salinity of the soil is based on the electrical conductivity of saturated soil extract and in table 8 is expressed in millimhos per centimeter at 25° C. Salinity not only affects the suitability of a soil for crop production but also affects the stability of a soil when it is used as construction material. In addition, salinity affects the degree to which construction materials placed in the soil will corrode.

Dispersion refers to the degree that the particles smaller than 0.005 millimeter are separated, or dispersed. In a dispersed soil the clay particles have run together, and the soil is more or less sealed. A dispersed soil is unstable, and its use for any engineering purpose is hazardous.

Shrink-swell potential indicates how much a soil expands and contracts upon wetting and drying. Generally, structures are difficult to maintain if they are constructed in or with soils that have high shrink-swell potential.

The soils listed in table 8 were placed in hydrologic groups according to the rate that the soils take in water after they have been thoroughly wetted and have swelled. This grouping is one of the factors used in determining the amount of runoff that can be expected from a watershed. The faster the intake, the slower the runoff. The soils in the survey area were placed into four groups that are defined as follows:

A. Soils that have a high infiltration rate when thoroughly wet. These soils consist mainly of deep, well-drained to excessively drained sand, gravel, or both. They transmit water rapidly and, as a result, have slow runoff.

B. Soils that have a moderate infiltration rate when thoroughly wet. These soils consist mainly of clay loam to fine sandy loam that is 20 to 60 inches thick. They transmit water at a moderate rate.

C. Soils that have a low infiltration rate when thoroughly wet. These soils consist mainly of (1) material that impedes the downward movement of water or (2) clay to heavy clay loam that has a slow rate of infiltration. These soils transmit water slowly.

D. Soils that have a very slow infiltration rate when thoroughly wet. These soils consist mainly of (1) clay that has a high shrink-swell potential; (2) soils that have a claypan or a clay layer at or near the surface; and (3) soils that are shallow over nearly impervious material. The soils in group D transmit water very slowly and, therefore, have rapid runoff.

Soil test data

To help evaluate the soils for engineering purposes, samples taken from seven profiles of important soil types in three series were tested according to standard procedures. The test data are given in table 10 (see p. 104). Because all samples were obtained at a depth of less than 6 feet, the test data may not be adequate for estimating the characteristics of soil materials where deep cuts are required in rolling areas.

Table 10 gives compaction (moisture-density) data for the tested soils. If a soil material is compacted at a successively higher moisture content, assuming that the compactive effect remains constant, the density of the material will increase until the optimum moisture content is reached. After that, the density decreases with an increase in moisture content. The highest dry density obtained in the compaction test is called maximum dry density. Moisture-density data are important to earthwork, because, generally, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The tests of liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a plastic to a liquid state. The plastic limit is the moisture content, on a dry basis, at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes to a liquid state. The plasticity index is the numerical difference between the liquid limit and plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Interpretations of engineering properties of soils

Table 11, beginning on p. 106, gives the suitability of soils as construction material and lists features that affect the design, construction, and maintenance of structures and the effectiveness of engineering practices. Interpretations are given for the entire soil series for those series made up of soils that are so uniform in features affecting engineering that they can be described as a group. Most soil series in the survey area are of this kind. Some soil series, however, consist of soil types that, from an engineering standpoint, vary considerably. These soil types are listed separately in table 11 so that more exact interpretations can be made. The miscellaneous land types Loamy alluvial land (Lo), Saline land (Sa), and Wet land (Wa) are so variable that interpretations for them are not made in table 11.

In table 11 ratings are given for the suitability of the soils as topsoil, gravel, and road fill. Suitability ratings for sand are not given in table 11 because only in Cobbly alluvial land does sand occur that makes suitable construction material. Cobbly alluvial land is a good source of sand, but the screening of pebbles from its material is necessary. Soils are rated poor or fair for topsoil if they are thin, low in organic-matter content, very gravelly, very cobbly, or very stony, or if they have a fine-textured, sticky surface layer. Considerable exploring of soils rated suitable for gravel may be required before material that meets the requirements is found.

Table 11 shows soil features that affect engineering practices and the construction and maintenance of structures.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification
			USDA (texture)
		Inches	
Absarokee clay loam (Aa and Ab; also in complexes Ah and Mb).	6 to 10 inches of clay loam underlain by 10 to 20 inches of clay loam or clay on thin layers of alternating shale and fractured sandstone; on gently sloping to moderately rolling, well-drained uplands. Hydrologic group C.	0–8 8–26	Clay loam Clay
Absarokee loam (in complexes Ad, Af, and Ag).	4 to 8 inches of loam underlain by 14 to 18 inches of heavy clay loam or light clay that grades to 4 to 6 inches of strongly calcareous clay loam or light clay over soft, coarse-grained sandstone; on well-drained, rolling uplands. Hydrologic group C.	0–6 6–20 20–25	Loam Heavy clay loam Heavy clay loam
Absarokee silty clay (Ac).	18 to 22 inches of noncalcareous clay or silty clay underlain by 4 to 10 inches of strongly calcareous clay that merges with shale containing few thin strata of sandstone; on rolling uplands. Hydrologic group C.	0–20 20–26	Clay or silty clay Clay
Adel loam (Ak and Al; also in undifferentiated soil groups Ra, Rd, and Rf). Adel silt loam (Am).	24 to 36 inches of organic loam or silt loam over layer that is loam and 15 percent pebbles; pebbles below 30 to 36 inches; bedrock at a depth greater than 60 inches; on smooth or concave, gentle to steep fans and foot slopes. Hydrologic group B.	0–30 30–60	Loam or silt loam Loam
Adel stony loam (in undifferentiated soil group Rn and complex Th).	8 to 30 inches of nearly black, highly organic stony loam underlain by light-colored strongly calcareous material; stones make up 10 to 20 percent of soil mass; on fans and foot slopes. Hydrologic group B.	0–16 16–60	Stony loam Stony loam
Alder clay loam (An and Ao; also in complexes Ar, As, Mc, and Wp). Alder stony clay loam (Ap; also in complex Wp).	10 to 15 inches of highly organic clay loam or stony clay loam underlain by 10 to 20 inches of clay on thin layers of alternating shale and fractured sandstone; on gently sloping to moderately rolling uplands. Hydrologic group C.	0–12 12–27	Clay loam or stony clay loam. Clay
Arvada clay loam (in complexes At, Au, Av, Aw, Bc, and Ro).	1 to 4 inches of clay loam or cobbly clay loam over dispersed clay that grades to saline clay or clay loam at 10 to 14 inches; on nearly level to sloping fans and terraces. Hydrologic group D.	0–12 12–60	Clay loam Clay or clay loam
Ashuelot gravelly loam (Ax; also in complex Ja).	4 to 20 inches of gravelly loam underlain by a cemented or semicemented very gravelly mass, 4 to 8 inches thick, that grades to noncemented very gravelly loam and very gravelly sandy loam; gravel beds are 10 to 50 feet thick. Hydrologic group B.	0–10 10–16 16–60	Gravelly loam Very gravelly loam, cemented. Very gravelly sandy loam.
Bainville loam (Ba).	1 to 2 feet of loam underlain by alternating thin layers of soft sandstone, siltstone, and soft shale. Hydrologic group B.	0–15	Loam
Beckton loam (Bb; also in complexes At, Au, Bc, Bd, and Bf). Beckton clay loam (in complex Bd).	4 to 8 inches of loam or clay loam underlain by more than 32 inches of clay that is dispersed in its upper part and is saline below. Hydrologic group C.	0–6 6–40	Loam or light clay loam Clay
Big Timber clay loam (in complex Ch).	1 to 1½ feet of clay loam underlain by reddish-colored shale interbedded with sandstone and siltstone; hilly relief. Hydrologic group C.	0–15	Clay loam
Blaine loam (in complex Bg).	18 to 30 inches of heavy loam or clay loam that grades to partly weathered igneous bedrock. Hydrologic group B.	0–24	Loam
Blaine stony loam (in complexes Bh and Sv).	12 to 20 inches of clay loam or light clay underlain by 8 to 40 inches of gravelly clay or gravelly clay loam that grades to igneous bedrock. Hydrologic group B.	0–16 16–24	Clay loam Gravelly clay
Blythe loam (Bk and Bm).	10 to 18 inches of loam underlain by 10 to 20 inches of clay that merges with clay loam or light clay (alluvium) on the fans and with shale on the rolling uplands. Hydrologic group D.	0–14 14–30	Loam Clay

estimated physical and chemical properties

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
					Inches per hour	*Inches per inch*				
CL	A–6	100	95–100	75–85	0.80–2.50	0.18	6.1–6.5	None	Low	Low.
CL or CH	A–7	100	90–95	75–85	0.80–2.50	.18	6.6–7.3	None	Low	Moderate.
ML	A–5	95–100	85–95	75–85	0.80–2.50	.17	6.1–6.5	None	Low	Low.
CL or CH	A–7	95–100	85–95	75–85	0.80–2.50	.18	6.6–7.3	None	Low	Moderate to high.
CL or CH	A–7	85–95	80–90	75–85	0.80–2.50	.17	7.9–8.6	None	Low	Moderate to high.
CH	A–7	95–100	95–100	85–95	0.20–0.80	.18	6.6–7.3	None	Low	High.
CH	A–7	85–95	85–95	80–90	0.20–0.80	.18	7.9–8.4	None	Low	High.
OL	A–4	95–100	95–100	70–80	2.5–5.00	.20	5.6–6.0	None	Low	Low.
ML or CL	A–4 or A–6	75–80	70–75	65–70	2.5–5.00	.16	6.1–7.3	None	Low	Low.
OL	A–4 or A–6	80–90	75–85	60–75	0.80–2.50	.17	5.6–6.3	None	Low	Low.
ML	A–4 or A–6	75–85	65–75	55–65	0.80–2.50	.15	6.6–7.3	None	Low	Low.
OL	A–5 or A–7	100	100	75–85	0.80–2.50	.20	5.6–6.0	None	Low	Low.
CL or CH	A–7	100	100	75–85	0.80–2.50	.20	6.6–7.3	None	Low	High.
CL or CH	A–6 or A–7	100	95–100	85–95	<0.20	.16	9.0	None	High	High.
CL or CH	A–6 or A–7	100	95–100	85–95	<0.20	.16	8.5–9.0	Moderate to severe.	High	High.
GM or SM	A–2	60–70	50–60	20–30	0.80–2.5	.10	7.4–7.8	None	Low	Low.
GM	A–2	30–40	25–35	15–25	0.80–2.50	.05	7.9–8.4	None	Low	Low.
GP-GM	A–1	20–30	15–25	5–10	2.5–5.0	.02	7.9–8.4	None	Low	Low.
ML	A–4 or A–6	100	95–100	80–90	0.8–2.5	.16	7.9–8.4	None	Low	Low.
CL	A–6 or A–7	100	95–100	85–95	0.20–0.80	.16	7.4–7.8	None	Moderate	Moderate.
CH	A–7	100	95–100	85–95	<0.20	.18	7.9–8.4	None	High	High.
CL	A–6 or A–7	80–90	70–80	60–70	0.20–0.80	.15	7.4–7.8	None	Low	Moderate to high.
CL	A–4 or A–6	100	95–100	80–90	0.80–2.50	.16	7.9–8.4	None	Low	Low to moderate.
CL	A–7	70–80	60–70	50–60	0.20–0.80	.15	7.9–8.4	None	Low	Moderate.
GC	A–6	60–70	50–60	40–50	0.80–2.50	.15	7.9–8.4	None	Low	Moderate.
ML or CL	A–4 or A–6	100	95–100	75–85	0.80–2.50	.20	7.4–7.8	None	Low	Low.
CH	A–7	100	95–100	75–85	<0.20	.18	7.9–8.4	Moderate	Moderate	High.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification
			USDA (texture)
		Inches	
Bowdoin silty clay, low clay variant (Bo).	3 to 5 inches of dark-colored silty clay underlain by 8 to 10 inches of lighter colored clay that grades to highly calcareous silty clay that, in some places, is stratified with gravelly clay loam and gravelly sandy loam; water table at 4 to 5 feet; on stream terraces. Hydrologic group D.	0–9 9–60	Silty clay Silty clay stratified with gravelly clay loam.
Bridger loam (Bp and Br).	6 to 10 inches of organic loam underlain by 10 to 20 inches of clay or clay loam that grades to gravelly and stony loam in which coarse fragments make up 10 to 30 percent of the soil mass; on slopes of 2 to 15 percent. Hydrologic group B.	0–8 8–15 15–60	Loam Clay loam or light clay Gravelly loam
Bridger stony loam (Bs).	5 to 10 inches of organic stony loam underlain by 10 to 20 inches of stony clay loam that grades to stony loam extending to a depth of 5 feet or more; coarse fragments make up 10 to 30 percent of the soil mass; on fans and foot slopes having slopes of 4 to 35 percent. Hydrologic group B.	0–7 7–15 15–60	Stony loam Stony clay loam Stony loam
Castle clay (Ca and Cb; also in complex Cc).	18 to 40 inches of clay containing 5 to 10 percent, by volume, of shale fragments and underlain by beds of clay shale; on rolling uplands. Hydrologic group D.	0–28	Clay
Chama clay loam (Cd; also in complexes Cf and Cg)	6 to 10 inches of dark-colored clay loam underlain by 2 to 3 feet of lighter colored, strongly calcareous clay loam that grades to clay loam shale; on rolling uplands. Hydrologic group B.	0–30	Clay loam
Cheadle channery loam (Ck, Cm; also in complexes Ad, Af, Dt, Sc, Sp, and Tk).	10 to 20 inches of channery loam underlain by fractured sandstone on rolling uplands. Hydrologic group C.	0–15	Channery loam
Cheadle loam (Cn, Co; also in complexes Dt, Tk).	14 to 24 inches of loam which make up as much as 10 percent of the soil mass; small fragments of rock grade to shattered sandstone; on rolling uplands. Hydrologic group C.	0–18	Loam
Cheadle stony loam (Cp; also in complexes Ag, Ch, Cr, Cs, Du, Sc, Sp, Tm, Tn, Wt).	8 to 18 inches of stony or channery loam underlain by fractured sandstone; on rolling to sharply rolling uplands. Hydrologic group C.	0–12	Stony or channery loam
Cobbly alluvial land (Cu).	5 feet or more of cobbly or gravelly sand or gravelly loamy sand; on narrow, recent flood plains. Hydrologic group A.	0–60	Gravelly loamy sand
Colvin clay loam (in complex Cv).	2 to 5 feet of poorly drained clay loam underlain by 2 to 4 feet of gravelly to very gravelly loam or very gravelly sandy clay loam; shale at a depth of 5 to 10 feet causes poor drainage; on narrow and broad terraces. Hydrologic group D.	0–36 36–60	Clay loam Very gravelly sandy clay loam.
Cowood stony loam (Cw; also in complex Cx).	1 to 2½ feet of gravelly to very gravelly silt loam underlain by weathered crumbly igneous rock that becomes harder with increasing depth; on steep mountainous slopes. Hydrologic group C.	0–20	Gravelly silt loam
Danvers clay loam (Da, Db, and Dc; also in complexes Bd, Dm, Dn, and Do).	10 to 14 inches of noncalcareous clay loam underlain by 12 to 48 inches of strongly calcareous clay loam that grades to very gravelly loam or very gravelly loamy coarse sand; gravel beds 10 to 80 feet thick, on nearly level to gently sloping high benches. Hydrologic group B.	0–12 12–30 30–60+	Clay loam Clay loam Very gravelly loam
Danvers cobbly clay loam (Dd, Df, Dp, and Dg). Danvers gravelly clay loam (Dh; also in complex Jp). Danvers stony clay loam (Dk).	10 to 14 inches of noncalcareous cobbly gravelly or stony clay loam underlain by 12 to 30 inches of strongly calcareous cobbly clay loam that grades to very cobbly or very gravelly loamy coarse sand or very gravelly or cobbly loam; gravel and cobble beds 5 to 50 feet thick; on gentle slopes of high benches and, to a lesser extent, on slopes of drainageways crossing the high benches. Hydrologic group B.	0–12 12–22 22–60+	Cobbly clay loam Cobbly clay loam Very gravelly loamy sand
Darret clay loam (Dr; also in complexes Dt, Du, and Dv).	3 to 5 inches of reddish-colored clay loam underlain by 4 to 12 inches of silty clay or heavy clay loam that grades to 6 to 20 inches of calcareous clay loam; clay loam merges with shale; on rolling uplands. Hydrologic group B.	0–4 4–15 15–24	Clay loam Silty clay Clay loam

estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0. 074 mm.)						
					Inches per hour	*Inches per inch*				
CH	A–7	98–100	95–100	85–95	0. 20–0. 80	0. 18	7. 4–7. 8	None	Low	High.
CH or CL	A–7	90–100	85–95	80–90	0. 20–0. 80	. 16	7. 9–8. 4	None to slight.	Low	High.
OL	A–4	85–95	80–90	65–75	1. 50–2. 50	. 20	6. 6–7. 3	None	Low	Low.
CL	A–6 or A–7	85–95	80–90	65–75	0. 80–2. 50	. 16	7. 4–7. 8	None	Low	Moderate to high.
GM or SM	A–2	60–80	50–70	15–30	2. 50–5. 00	. 10	7. 9–8. 4	None	Low	Low.
OL	A–4 or A–6	70–80	60–70	50–65	0. 80–2. 50	. 18	6. 6–7. 3	None	Low	Low.
CL	A–7	70–80	60–70	50–65	1. 50–2. 50	. 18	7. 4–7. 8	None	Low	Moderate.
GM or SM	A–2	50–70	40–50	15–30	2. 50–5. 00	. 10	7. 9–8. 4	None	Low	Low.
CH	A–7	95–100	90–100	85–95	<0. 20	. 20	7. 9–8. 4	None	Low	High.
CL	A–6 or A–7	100	95–100	85–95	0. 80–2. 50	. 16	7. 9–8. 4	None	Low	Moderate.
GM	A–4	70–80	55–65	45–55	0. 80–2. 50	. 15	7. 4–8. 4	None	Low	Low.
ML	A–4	85–95	75–85	60–70	0. 80–2. 50	. 16	7. 4–8. 4	None	Low	Low.
GM or SM	A–4	65–75	50–60	40–50	0. 80–2. 50	. 15	7. 4–8. 4	None	Low	Low.
GP–GM or SP–SM.	A–1	50–60	15–25	5–10	5. 0–10. 0	. 06	7. 4–7. 8	None	Low	Low.
CL or CH	A–6 or A–7	100	90–100	85–95	0. 80–2. 50	. 16	7. 9–8. 4	None	Low	Moderate.
GM or GC	A–2	35–45	25–35	20–30	2. 50–5. 00	. 10	7. 9–8. 4	None	Low	Low.
GM	A–2	40–50	30–40	25–35	2. 50–5. 00	. 10	5. 1–6. 0	None	Low	Low.
CL	A–6 or A–7	95–100	85–95	80–90	0. 80–2. 50	. 16	6. 6–7. 3	None	Low	Moderate.
CL	A–7	90–95	80–90	75–85	0. 80–2. 50	. 17	7. 9–8. 4	None	Low	Moderate.
GP–GM	A–1	20–30	15–25	5–10	5. 0–10. 0	. 02	7. 9–8. 4	None	Low	Low.
CL	A–6 or A–7	75–85	70–80	65–75	0. 80–2. 50	. 15	6. 6–7. 3	None	Low	Moderate.
CL	A–7	70–80	65–75	60–70	0. 80–2. 50	. 15	7. 9–8. 4	None	Low	Moderate.
GP-GM	A–1	20–30	15–25	5–10	5. 0–10. 0	. 02	7. 9–8. 4	None	Low	Low.
CL	A–6 or A–7	100	100	85–95	0. 80–2. 50	. 18	7. 4–7. 8	None	Low	Low.
CL or CH	A–7	100	100	85–95	0. 20–0. 80	. 18	7. 4–7. 8	None	Low	Moderate.
CL	A–6 or A–7	70–80	65–75	60–70	0. 80–2. 50	. 16	7. 9–8. 2	None	Low	Moderate.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification
			USDA (texture)
		Inches	
Darret stony clay loam (Ds).	10 to 15 inches of stony clay loam or light stony clay underlain by 8 to 20 inches of calcareous clay loam that merges with the underlying shale; on rolling uplands. Hydrologic group B.	0–12 12–24	Stony clay loam Clay loam
Dimmick clay (Dw).	20 to 30 inches of nearly noncalcareous clay that grades to lighter colored, noncalcareous clay mottled with iron; water table 2 to 4 feet; in depressions. Hydrologic group D.	0–60	Clay
Duncom stony loam (Dx; also in complexes Cs, Dy, Dz, Hu, Sr, and St).	4 to 5 inches highly organic, black stony loam underlain by highly calcareous stony or gravelly loam that is 6 to 12 inches thick and merges with limestone bedrock; on rolling to hilly topography in the foothills. Hydrologic group D.	0–4 4–12	Stony loam Stony loam
Fargo silty clay (in complex Fa).	5 feet or more of poorly drained silty clay that, in some places, is stratified with sandy clay or clay loam containing a few pebbles at a depth below 30 inches; water table generally occurs at a depth of 2 to 5 feet; on bottoms of valleys. Hydrologic group D.	60+	Silty clay
Fergus clay loam (Fc, Fd, Ff, and Fh).	5 to 7 inches of reddish-colored clay loam underlain by 15 to 30 inches of heavy clay loam, silty clay loam, or silty clay that grades to strongly calcareous clay loam; on stream terraces with slopes of 0 to 4 percent and on fan terraces with slopes of 2 to 15 percent. Hydrologic group B.	0–6 6–24 24–60	Clay loam Heavy clay loam Clay loam
Fergus silty clay loam, shale substratum (Fs).	5 to 7 inches of reddish-colored silty clay loam underlain by 15 to 30 inches of heavy clay loam that grades to 10 to 15 inches of highly calcareous clay loam that merges with shale; few pebbles and cobblestones in upper part; on rolling uplands. Hydrologic group B.	0–6 6–20 20–32	Silty clay loam Heavy clay loam Clay loam
Gallatin clay loam (Ga; also in mapping unit Gd).	10 to 14 inches of organic clay loam that grades to 20 to 50 inches of clay loam underlain by variable stratified sandy loam, gravelly sandy loam, and loamy sand mixed with gravel; iron mottling; water table fluctuates between 2 and 6 feet of the surface; on low bottoms along some of the major drainageways. Hydrologic group C.	0–12 12–48 48–72	Clay loam Clay loam Stratified sandy loam; loam, loamy sand all mixed with gravel in varying amounts.
Gallatin loam (Gb; also in mapping unit Gd and in undifferentiated soil group Gr).	10 to 14 inches of organic loam that grades to 20 to 50 inches of dominantly loam, which is underlain by variable stratified sandy loam and loamy sand mixed with gravel; water table fluctuates between 2 and 6 feet of the surface; on low bottoms along drainageways. Hydrologic group C.	0–12 12–48 48–72	Loam Loam Stratified loam, sandy loam, loamy sand all mixed with gravel in varying amounts.
Gallatin loam, clay substratum (Gc).	8 to 30 inches of loam underlain by clay that extends to a depth of 50 inches or more; water table 1 to 3 feet from the surface; on low bottoms along some of the major drainageways. Hydrologic group D.	0–12 12–60	Loam Clay
Hegne silty clay (in complex Fa).	5 feet or more of poorly drained silty clay; water table at depth of 2 to 5 feet; on valley floors. Hydrologic group D.	60+	Silty clay
Hughesville clay loam (in complex Hu).	18 to 30 inches of dominantly clay loam underlain by limestone bedrock; occupies part of steeply rolling Hughesville-Duncom complex. Hydrologic group C.	0–24	Clay loam
Hughesville stony clay loam (in complexes Hu and St).	18 to 30 inches of dominantly stony clay loam underlain by limestone; occupies part of steeply rolling Hughesville-Duncom complex. Hydrologic group C.	0–24	Stony clay loam
Judith clay loam (Jb, Jc, Jd, and Jf; also in complexes Dm, Dn, Do and Wk; also in undifferentiated soil group Jt).	6 to 10 inches of weakly calcareous clay loam over highly calcareous clay loam that is 5 to 10 percent gravel and grades to very gravelly loamy coarse sand below 30 to 36 inches; gravel beds 10 to 80 feet thick; on nearly level high benches. Hydrologic group B.	0–6 6–30 30–60	Clay loam Clay loam Very gravelly loamy coarse sand.

estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
					Inches per hour	*Inches per inch*				
CL	A-6 or A-7	80–90	75–85	65–75	0.80–2.50	0.15	7.4–7.8	None	Low	Low. to moderate
CL	A-7	80–95	70–80	60–70	0.80–2.50	.16	7.9–8.2	None	Low	Moderate.
CH	A-7	100	100	95–100	>0.20	.18	7.4–7.8	None	Moderate	High.
OL	A-4 or A-6	75–85	60–75	50–60	0.80–2.50	.18	6.6–7.3	None	Low	Low.
ML	A-4 or A-6	75–85	60–75	50–60	0.80–2.50	.16	7.9–8.4	None	Low	Low.
CH	A-7	100	100	95–100	>0.20	.18	8.5–9.0	None	Moderate	High.
CL	A-6 or A-7	100	100	85–95	0.80–2.50	.17	6.6–7.3	None	Low	Low.
CL or CH	A-7	100	100	90–100	0.80–2.50	.18	7.4–7.8	None	Low	Moderate.
CL	A-6 or A-7	95–100	85–95	80–90	0.80–2.50	.16	7.4–7.8	None	Low	Moderate.
CL	A-6 or A-7	95–100	85–95	75–90	0.80–2.50	.17	6.6–7.3	None	Low	Low.
CL or CH	A-7	90–100	85–95	75–90	0.80–2.50	.18	7.4–7.8	None	Low	Moderate.
CL	A-6 or A-7	80–90	70–80	60–70	0.80–2.50	.16	7.9–8.2	None	Low	Moderate.
OL	A-6	100	100	95–100	0.80–2.50	.20	7.3–7.8	None	Low	Low.
CL	A-6 or A-7	100	100	80–90	0.80–2.50	.17	7.9–8.4	None	Low	Moderate.
GM	A-2	40–60	30–50	20–30	2.50–5.00	.05	4.9–8.4	None	Low	Very low.
OL	A-4	100	100	95–100	0.80–2.50	.20	7.3–7.8	None	Low	Low.
ML	A-4 or A-6	100	100	75–85	0.80–2.50	.17	7.9–8.4	None	Low	Low.
GM	A-2	40–60	30–50	15–30	0.80–5.00	.05	7.9–8.4	None	Very low	Very low.
OL	A-4	100	100	75–85	0.80–2.50	.18	7.9–8.4	None	Low	Low.
CH	A-7	100	100	85–95	<0.20	.18	7.9–8.4	None	Low	High.
CH	A-7	100	100	95–100	0.20	.18	8.5–9.0	None	Moderate	High.
CL	A-6 or A-7	90–100	90–100	85–95	0.80–2.50	.16	8.4–8.8	None	Low	Low to moderate.
GC	A-4 or A-6	55–65	50–60	40–50	0.80–2.50	.15	8.4–8.8	None	Low	Low to moderate.
CL or ML	A-7 or A-6	90–100	85–95	70–80	0.8–2.5	.16	6.6–7.3	None	Low	Low.
CL or ML	A-6	80–90	70–80	50–60	0.8–2.5	.14	7.9–8.4	None	Low	Low.
GP-GM	A-1	20–30	15–25	5–10	5.0–10.0	.02	7.9–8.4	None	Low	Low.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification
			USDA (texture)
		Inches	
Judith cobbly clay loam (Jh and Jk; also in complex Uh). Judith gravelly clay loam (Jl, Jm, Jn, Jo; also in complexes Dp, Ja, Jp, Ju, Jv, Ug, and Wk; also in undifferentiated soil groups Jr, Jt, and Js). Judith gravelly loam (in complex Ug). Judith loam (in complex Ug). Judith stony loam (in undifferentiated soil groups Jr and Js and in complex Uh).	8 to 12 inches of weakly calcareous cobbly or gravelly loam or cobbly or gravelly clay loam over highly calcareous gravelly clay loam that grades to very gravelly loamy coarse sand or very gravelly sandy loam below 30 to 36 inches; on gentle slopes of high benches. Hydrologic group B.	0–10 10–24 24–60	Cobbly or gravelly clay loam or loam. Gravelly clay loam Very gravelly loamy coarse sand.
Lamoure clay loam (in complex Cv).	8 to 12 inches of organic clay loam that grades to 20 to 50 inches of calcareous, poorly drained, gray-colored clay loam that is gleyed and underlain by very gravelly sandy loam or very gravelly loamy sand; in narrow bands along some of the major drainageways and in broader areas in complex association with the Colvin soils on higher terraces. Hydrologic group D.	0–12 12–40 40–60	Clay loam Clay loam Very gravelly sandy loam or very gravelly loamy sand.
Laurel clay loam (in complex Av).	4 feet or more of strongly saline heavy silty clay loam or light clay; nearly barren of vegetation; in complex with the Arvada soils on stream terraces and fans. Hydrologic group D.	48+	Silty clay
Lismas clay (in complexes La and Lc).	4 to 12 inches of clay that grades to thick beds of clay shale; on hilly residual uplands. Hydrologic group D.	0–8	Clay
Little Horn stony loam (Lh).	5 to 8 inches of highly organic stony loam underlain by 6 to 10 inches of stony or cobbly clay loam that grades to strongly calcareous stony or cobbly loam or light clay loam underlain by limestone, sandstone, and quartzite bedrock; on rolling uplands. Hydrologic group C.	0–6 6–14 14–30	Stony loam Stony clay loam Stony loam
Loberg stony loam (Lr; also in complexes Ls and Wr).	10 to 16 inches of stony loam underlain by 20 to 50 inches of stony clay or stony heavy clay loam that grades to shale or sandstone; on rolling uplands in foothills. Hydrologic group C.	0–12 12–40	Stony loam Stony clay
Maginnis channery clay loam (in complexes Ah, Ar, As, Mb, and Mc.)	8 to 18 inches of channery clay loam underlain by thin layers of alternating shale and fractured sandstone; on rolling to hilly uplands in complex with the Absarokee or Alder soils. Hydrologic group D.	0–12	Channery clay loam
Maginnis cobbly clay loam (Ma).	8 to 20 inches of cobbly clay loam overlying thin layers of alternating shale and sandstone; on gravel-capped edges of benches. Hydrologic group D.	0–14	Cobbly clay loam
Midway clay loam (Mw; also in complexes Cf, Cg, and Mx).	8 to 20 inches of calcareous clay loam overlying soft, platy shale that in some places, is stratified with thin layers of sandstone; on steep, hilly relief. Hydrologic group C.	0–14	Clay loam
Pierre clay (Pc and Pd; also in complex La).	10 to 14 inches of nonsaline clay that grades to 5 to 22 inches of moderate saline clay underlain by shale; on rolling uplands. Hydrologic group D.	0–12 12–24	Clay Clay
Promise clay (Pm, Po, and Pp). Promise cobbly clay (Pr).	15 to 20 inches of dominantly noncalcareous clay underlain by calcareous clay that commonly grades to clay shale at 3 to 5 feet; on gently rolling uplands and, to a lesser extent, on nearly level benches and terraces.	0–18 18–36	Clay Clay
Raynesford loam (in undifferentiated soil groups Gr, Ra, Rd, and Rf; also in complex Ss).	8 to 16 inches of nearly black, highly organic loam underlain by light-colored, strongly calcareous loam; on fans and foot slopes.	0–12 12–60	Loam Loam

estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0. 074 mm.)	*Inches per hour*	*Inches per inch*				
ML or CL	A–4 or A–6	70–90	65–75	50–65	0. 8–2. 5	0. 15	6. 6–7. 3	None	Low	Low.
GM	A–2–4	30–40	25–35	15–25	0. 8–2. 5	. 05	7. 9–8. 4	None	Low	Low.
GP–GM	A–1	20–30	15–25	5–10	5. 0–10. 0	. 02	7. 9–8. 4	None	Low	Low.
OL	A–6 or A–7	100	100	90–95	0. 8–2. 5	. 20	7. 3–7. 9	None	Low	Moderate.
CL	A–6 or A–7	100	100	80–90	0. 8–2. 50	. 18	7. 9–8. 4	None	Low	Moderate.
GM or GC	A–2	40–60	30–50	15–30	2. 50–5. 00	. 05	7. 9–8. 4	None	Low	Low.
CL or CH	A–6 or A–7	100	95–100	85–95	0. 20	. 16	7. 4–8. 4	Severe	High	High.
CL or CH	A–7	95–100	85–95	80–90	<0. 20	. 17	7. 9–8. 4	Slight to moderate.	Moderate to high.	High.
OL	A–4	65–85	60–70	50–60	0. 8–2. 50	. 18	7. 4–7. 8	None	Low	Low.
CL	A–6 or A–7	65–85	60–70	50–60	0. 8–2. 50	. 15	7. 9–8. 4	None	Low	Moderate.
GM	A–4 or A–6	65–85	50–60	40–50	0. 8–2. 50	. 15	7. 9–8. 4	None	Low	Low.
CL	A–6 or A–7	60–80	60–70	50–60	0. 80–2. 50	. 13	5. 1–5. 5	None	Low	Moderate.
CL or CH	A–7	60–80	60–70	55–65	0. 20–0. 80	. 14	6. 1–7. 8	None	Low	High.
GC	A–2	40–50	35–45	25–35	0. 80–2. 50	. 08	6. 6–7. 3	None	Low	Low.
GC	A–2	40–50	35–45	25–35	0. 80–2. 50	. 08	6. 6–7. 3	None	Low	Low.
CL	A–6 or A–7	75–85	70–80	60–75	0. 20–0. 80	. 15	8. 5–9. 0	Slight to moderate.	Low	Moderate.
CH	A–7	95–100	95–100	85–95	<0. 20	. 18	7. 4–7. 8	Low	Low	High.
CH	A–7	85–95	80–90	70–80	<0. 20	. 18	7. 9–8. 4	Moderate	Moderate	High.
CH	A–7	90–100	90–100	85–95	<0. 20	. 18	7. 9–8. 4	None	Low	High.
CH	A–7	90–100	90–100	85–95	<0. 20	. 18	7. 9–8. 4	Low	Low	High.
OL	A–4	95–100	85–95	70–80	0. 80–2. 50	. 20	7. 9–8. 4	Low	Low	Low.
ML or CL	A–4	85–95	80–90	60–70	0. 80–2. 50	. 16	7. 9–8. 4	Low	Low	Low.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification: USDA (texture)
		Inches	
Raynesford stony loam (in undifferentiated soil groups Jr, Js, and Rn).	8 to 30 inches of nearly black, highly organic stony loam underlain by light-colored, strongly calcareous material; stones make up 10 to 20 percent of soil mass; on fans and foot slopes.	0–16 16–60	Stony loam Stony loam
Rhoades loam (in complex Ro). Rhoades clay loam (in complex Wm).	4 to 8 inches of loam or clay loam underlain by a dense clay-pan layer 12 to 15 inches thick which merges with shale commonly interbedded with sandstone; on gently rolling uplands.	0–6 6–20	Loam or clay loam Clay
Sapphire loam (in complexes Ls, Sb, and Sc).	6 to 10 inches of loam underlain by 12 to 20 inches of clay loam that merges with underlying shattered sandstone; developed under forest on sharply rolling topography in the foothills.	0–8 8–24	Loam Clay loam
Sapphire stony loam (in complexes Ls and Sb).	6 to 10 inches of stony loam underlain by 12 to 20 inches of stony clay loam that merges with underlying sandstone; on steeply rolling uplands in close association with Sapphire loam.	0–8 8–24	Stony loam Stony clay loam
Savage silty clay (Sd, Se, and Sf; also in complex Bf).	3 to 5 inches of light silty clay underlain by 14 to 18 inches of noncalcareous clay that grades to calcareous clay, clay loam, or gravelly clay loam; stratification is common; on stream terraces and fans. Hydrologic group C.	0–5 5–20 20–60	Silty clay Clay Clay and clay loam, stratified.
Savage silty clay loam (Sg, Sh, Sk; also in undifferentiated soil group Jt).	4 to 6 inches of silty clay loam underlain by 15 to 24 inches of generally noncalcareous silty clay or heavy silty clay that grades to strongly calcareous silty clay loam commonly stratified with gravelly clay loam; on stream terraces and fans. Hydrologic group B.	0–5 5–18 18–60	Silty clay loam Silty clay Silty clay loam
Skaggs clay loam (Sm and Sn; also in complexes Ss, St, and Sr).	6 to 9 inches of nearly black, highly organic clay loam underlain by 12 to 30 inches of light-colored, highly calcareous clay loam that merges with underlying limestone and limy shale; on rolling uplands. Hydrologic group C.	0–7 7–30	Clay loam Clay loam
Skaggs stony clay loam (So; also in complexes Dz, Sr, Ss, and St).	5 to 8 inches of nearly black, highly organic stony clay loam underlain by 10 to 20 inches of light-colored, strongly calcareous stony clay loam that merges with underlying limestone and shale bedrock; on rolling uplands. Hydrologic group C.	0–6 6–20	Stony clay loam Stony clay loam
Skaggs loam (Sl; also in complexes Sp and Ss).	3 to 8 inches of nearly black loam underlain by 15 to 30 inches of light-colored, strongly calcareous loam that merges with underlying soft sandstone and shale. Hydrologic group C.	0–5 5–24	Loam Loam
Slocum loam (Su).	12 to 18 inches of nearly black loam underlain by lighter colored clay loam or loam; noncalcareous throughout; water table fluctuates between 2½ and 6 feet of the surface; in narrow valleys in foothills. Hydrologic group B.	0–16 16–60	Loam Loam or clay loam
Spring Creek loam (in complex Bg).	4 to 8 inches of dark-colored loam underlain by 8 to 12 inches of lighter colored, calcareous loam; on gently rolling uplands in complex with Blaine loam. Hydrologic group C.	0–16	Loam
Spring Creek stony loam (in complexes Bh, Sv, and Ws).	4 to 8 inches of dark-colored stony loam underlain by 3 to 12 inches of lighter colored, strongly calcareous stony or very stony loam; on hilly uplands. Hydrologic group C.	0–6 6–12	Stony loam Stony loam
Straw clay loam (Sw and Sx).	6 to 10 inches of dark-colored, noncalcareous or only weakly calcareous clay loam underlain by lighter colored, calcareous clay loam that, in some places, is stratified with loam and contains scattered pebbles; on recent stream terraces and fans. Hydrologic group B.	0–8 8–60	Clay loam Clay loam
Straw clay loam, gravelly substratum (Sy).	6 to 10 inches of dark-colored clay loam underlain by 15 to 26 inches of lighter colored, strongly calcareous clay loam that merges with underlying very gravelly loamy sand; on stream terraces. Hydrologic group B.	0–8 8–25 25–60	Clay loam Clay loam Very gravelly loamy sand.

estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch*				
OL	A-4 or A-6	80–90	75–85	60–75	0.80–2.50	0.17	5.6–6.5	None	Low	Low.
ML	A-4 or A-6	75–85	65–75	55–65	0.80–2.50	.15	6.6–7.3	None	Low	Low.
ML–CL	A-4 or A-6	95–100	95–100	80–90	0.80–2.50	.16	6.6–7.3	None	Low	Low.
CH	A-7	85–95	80–90	70–80	0.20	.17	7.4–7.8	Low	Moderate	High.
ML or CL	A-4 or A-6	95–100	95–100	70–80	0.80–2.50	.15	6.1–6.5	None	Low	Low.
CL	A-6	80–95	75–85	65–75	0.80–2.50	.16	6.6–7.3	None	Low	Moderate.
ML or CL	A-4 or A-6	70–90	65–85	55–65	0.8–2.50	.14	6.1–6.5	None	Low	Low.
CL	A-6	65–85	60–80	50–60	0.8–2.50	.14	6.6–7.3	None	Low	Low.
CH	A-7	100	100	85–95	0.20–0.80	.18	7.4–7.8	None	Low	High.
CH	A-7	100	100	85–95	0.20–0.80	.18	7.9–8.4	None	Low	High.
CL or CH	A-6 or A-7	90–100	90–100	80–95	0.20–0.80	.16	8.5–9.0	Low	Low	Moderate to high.
CL	A-6 or A-7	100	100	85–95	0.80–2.50	.16	7.4–7.8	None	Low	Moderate.
CH	A-7	100	100	85–95	0.20–0.80	.17	7.9–8.4	None	Low	High.
CL	A-6 or A-7	90–100	85–100	75–90	0.20–0.80	.16	8.5–9.0	Low	Low to moderate.	Moderate.
OL	A-4 or A-6	90–100	90–100	80–90	0.80–2.50	.18	6.6–7.3	None	Low	Low to moderate.
CL	A-6 or A-7	90–100	85–95	75–85	0.80–2.50	.16	7.9–8.4	None	Low	Moderate.
OL or CL	A-4 or A-6	70–90	65–85	60–70	0.80–2.50	.16	6.6–7.3	None	Very low	Low to moderate.
CL	A-7	65–85	60–80	50–60	0.80–2.50	.14	7.9–8.4	None	Very low	Moderate.
OL	A-4	95–100	85–95	80–90	0.80–2.50	.17	7.4–8.4	None	Very low	Low.
ML	A-4 or A-6	85–95	80–90	75–85	0.80–2.50	.15	7.9–8.4	None	Very low	Low.
OL	A-4 or A-6	100	100	85–95	2.50–5.00	.18	5.1–5.5	None	Very low	Low.
ML or CL	A-6 or A-7	100	95–100	85–95	0.80–2.50	.16	5.1–5.5	None	Very low	Low to moderate.
ML	A-4	85–95	75–85	60–70	0.8–2.50	.16	7.4–8.4	None	Low	Low.
GC	A-6	50–60	50–60	40–50	0.80–2.50	.12	7.4–7.8	None	Low	Low.
GC	A-2 or A-4	40–50	40–50	30–40	0.80–2.50	.10	7.9–8.4	None	Low	Low.
CL	A-6 or A-7	95–100	95–100	85–95	0.80–2.50	.16	7.9–8.4	None	Low	Low to moderate.
CL	A-6 or A-7	90–100	85–95	80–90	0.80–2.50	.15	7.9–9.0	None	Low	Low to moderate.
CL	A-6 or A-7	95–100	95–100	85–95	0.80–2.50	.16	7.9–8.4	None	Low	Moderate.
CL	A-6 or A-7	85–95	80–90	70–80	0.80–2.50	.15	7.9–8.4	Low	Low	Low to moderate.
GP–GM	A-1	20–30	15–25	5–10	5.0–10.0	.02	7.9–8.4	Low	Low	Very low.

TABLE 8.—*Brief descriptions of soils and their*

Soil type and map symbol	Description of soil and site	Depth from surface	Classification
			USDA (texture)
		Inches	
Terrad clay (Ta and Tb; also in complex Aw).	14 to 24 inches of noncalcareous, reddish-colored clay underlain by 1 to 3 feet of calcareous clay that merges with clay shale; on rolling uplands. Hydrologic group D.	0–18 18–40	Clay Clay
Terrad silty clay (Tc).	15 to 25 inches of noncalcareous, reddish-colored silty clay underlain by calcareous silty clay; on nearly level terraces. Hydrologic group C.	0–18 18–60	Silty clay Silty clay
Teton loam (Td and Tf; also in complexes Tm and Tn).	8 to 10 inches of black, highly organic loam underlain by 8 to 20 inches of lighter colored loam or clay loam that grades to 8 to 20 inches of very gravelly or very cobbly loam; underlain by shattered sandstone; on rolling uplands. Hydrologic group B.	0–9 9–20 20–40	Loam Loam Very gravelly loam
Teton channery loam (in complex Tk).	6 to 10 inches of nearly black channery loam underlain by 12 to 30 inches of lighter colored channery loam that merges with shattered sandstone; on rolling uplands. Hydrologic group B.	0–8 8–36	Channery loam Channery loam
Teton stony loam (in complexes Th, Tm, Tn, and Wt).	6 to 10 inches of nearly black, highly organic stony loam underlain by 12 to 30 inches of stony or channery loam that merges with shattered sandstone; in complex with Cheadle soils on rolling to hilly uplands. Hydrologic group B.	0–8 8–30	Stony loam Channery or stony loam
Twin Creek loam (To, Tp, and Tr).	6 to 30 inches of reddish-colored, noncalcareous or weakly calcareous loam underlain by moderately to strongly calcareous loam that, in some places, is stratified with clay loam or sandy loam containing small amounts of gravel; on stream terraces and fans. Hydrologic group B.	0–15 15–60	Loam Loam
Twin Creek clay loam (Tw).	6 to 15 inches of reddish-colored, weakly calcareous clay loam underlain by strongly to moderately calcareous clay loam; on stream terraces. Hydrologic group B.	0–10 10–60	Clay loam Clay loam
Utica gravelly loam (Ua, Ub; also in complexes Dv, Ju, Jv, Ug, Uh, and Wn). Utica stony loam (in complexes Ju, Jv, and Uh).	4 to 7 inches of dark-colored gravelly loam or stony loam underlain by beds of limy pebbles and cobblestones mixed with loam, sandy loam, or loamy sand that makes up 20 to 40 percent of the beds; on edges of benches and on ridges of benches and terraces. Hydrologic group B.	0–5 5–60	Gravelly loam or stony loam. Very gravelly loam or very gravelly loamy sand.
Winifred clay loam (Wb, Wc, and Wd; also in complexes Wk, Wm, and Wn).	10 to 14 inches of noncalcareous or weakly calcareous heavy clay loam or light clay underlain by 20 to 36 inches of light clay or heavy clay loam that contains prominent to distinct segregations of lime and grades to shale in place or locally transported material; on rolling uplands and on foot slopes. Hydrologic group C.	0–12 12–36	Clay loam Light clay
Winifred cobbly clay loam (Wf and Wh).	10 to 14 inches of cobbly clay loam underlain by 20 to 36 inches of cobbly clay loam that contains distinct to prominent segregations of lime and grades to shale in place or transported material; cobblestones make up 10 to 20 percent of soil mass throughout; on foot slopes and rolling uplands. Hydrologic group C.	0–12 20–36	Cobbly clay loam Cobbly clay loam
Woodhurst stony loam (Wo; also in complexes Wp, Wr, Ws, and Wt).	10 to 16 inches of nearly black stony loam that is 40 to 50 percent stone, by volume, and is underlain by 5 to 20 inches of lighter colored very stony clay loam that is 50 to 70 percent stones and cobblestones, grades to weathered igneous rock; noncalcareous throughout; on rolling to hilly uplands in the foothills. Hydrologic group B.	0–12 12–24	Stony loam Very stony clay loam

estimated physical and chemical properties—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction (pH)	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch*				
CH	A-7	100	100	75–85	0.20–0.80	0.18	6.1–7.3	Low	Low	High.
CH	A-7	100	100	75–85	0.20–0.80	.18	7.4–8.4	Low	Low	High.
CL or CH	A-7	100	100	75–85	0.20–0.80	.18	6.1–7.3	Low	Low	High.
CL or CH	A-7	100	100	75–85	0.20–0.80	.18	7.4–8.4	Low	Low	High.
OL	A-4 or A-6	95–100	90–100	75–85	0.80–2.50	.18	5.6–6.5	None	Low	Low.
ML or CL	A-4 or A-6	85–95	85–95	70–80	0.80–2.50	.16	5.6–6.5	None	Low	Low.
GP-GM	A-1-a	30–50	25–40	10–20	2.50–5.00	.05	6.6–7.3	None	Low	Low.
OL	A-4 or A-6	80–90	75–85	60–75	0.80–2.50	.18	5.6–6.5	None	Low	Low.
ML	A-4	75–85	70–80	55–70	0.80–2.50	.14	6.6–7.3	None	Low	Low.
OL	A-4 or A-6	80–90	75–85	60–75	0.80–2.50	.17	5.6–6.5	None	Low	Low.
ML	A-4 or A-6	75–85	65–75	55–65	0.80–2.50	.15	6.6–7.3	None	Low	Low.
ML	A-4 or A-6	95–100	80–90	70–80	0.80–2.50	.16	6.6–7.3	None	Low	Low.
ML or CL	A-4 or A-6	85–95	80–90	70–80	0.80–2.50	.15	7.9–8.4	None	Low	Low to moderate.
CL	A-6 or A-7	95–100	95–100	85–95	0.80–2.50	.16	6.6–7.3	None	Low	Moderate.
CL	A-6 or A-7	95–100	95–100	85–95	0.80–2.50	.16	7.9–8.4	None	Low	Moderate.
SM	A-4	50–60	45–55	40–50	2.50–5.00	.10	7.9–8.4	None	Low	Low.
GP-GM	A-1	20–30	15–25	5–10	5.00–10.00	.02	8.5–9.0	None	Low	Low.
CL or CH	A-6 or A-7	95–100	95–100	75–85	0.80–2.50	.16	7.4–7.8	None	Low	Moderate to high.
CL or CH	A-6 or A-7	90–100	85–95	70–80	0.20–0.80	.17	7.4–7.8	None	Low	Moderate to high.
CL or CH	A-6 or A-7	80–90	75–85	60–70	0.80–2.50	.15	7.4–7.8	None	Low	Moderate.
CL or CH	A-6 or A-7	75–85	70–80	55–65	0.20–0.80	.15	7.4–7.8	None	Low	Moderate.
GM	A-1	50–60	40–50	10–15	2.50–5.00	.10	7.4–7.8	None	Low	Low.
GP or GM	A-1	30–50	25–40	5–10	2.50–5.00	.08	7.9–8.4	None	Low	Low.

TABLE 9.—*Key for use with table 8 in obtaining estimated physical and chemical properties in soil complexes and undifferentiated soil groups*

Map symbols	Soil complexes and undifferentiated soil groups	Soil sites and percentages of main soils	Main soil types
Ad, Af	Absarokee-Cheadle channery loams.	On slopes of 2 to 15 percent in rolling uplands. Cheadle soil on knolls and ridges and makes up 15 to 40 percent of complex; Absarokee soil on side slopes and makes up 60 to 85 percent.	Absarokee loam. Cheadle channery loam.
Ag	Absarokee-Cheadle stony loams.	On irregular, gentle to moderate slopes of upland plains. Cheadle soil on ridges and knolls and makes up 30 to 50 percent of complex; Absarokee soil between ridges and knolls and makes up 40 to 70 percent.	Absarokee loam. Cheadle stony loam.
Ah	Absarokee-Maginnis channery clay loams.	On slopes of 2 to 8 percent in gently rolling uplands. Maginnis soil on knolls and rises and makes up 20 to 40 percent of complex; Absarokee soil surrounds knolls and ridges and makes up 60 to 80 percent.	Absarokee clay loam. Maginnis channery clay loam.
Ar	Alder-Maginnis channery clay loams, 2 to 8 percent slopes.	On slopes of 2 to 8 percent in gently rolling uplands. Maginnis soil on knolls and rises and makes up 30 to 50 percent of the complex; Alder soil on side slopes between rises and makes up 50 to 70 percent.	Alder clay loam. Maginnis channery clay loam.
As	Alder-Maginnis complex, 8 to 35 percent slopes.	In hilly or sharply rolling areas. Maginnis soil on steep crests, ridges, and knolls and makes up 20 to 50 percent of the complex; Alder soil on side slopes below crests and ridges and makes up 50 to 80 percent.	Alder clay loam. Maginnis channery clay loam.
At	Arvada-Beckton cobbly clay loams.	In depressional areas of high benches. Arvada soil in slight depressions and makes up 60 to 70 percent of complex; Beckton soil in slightly higher positions and makes up 30 to 40 percent.	Arvada cobbly clay loam. Beckton loam.
Au	Arvada-Beckton complex, saline.	In seeps or other poorly drained areas. Soils similar to Arvada and Beckton soils on benches and high terraces.	Arvada clay loam. Beckton loam.
Av	Arvada-Laurel complex	On terraces and gently sloping fans. Laurel soil in barren spots and makes up 20 to 40 percent of the complex; Arvada soil in the grassed areas and makes up the rest.	Arvada clay loam. Laurel clay loam.
Aw	Arvada-Terrad clays	On gently rolling uplands on fans, and in swales. Arvada soil in the slightly depressional areas and makes up 30 to 60 percent of the complex; Terrad soil in the higher areas and makes up most of the rest.	Arvada clay. Terrad clay.
Bc	Beckton-Arvada clay loams.	On fans and stream terraces. Beckton soil makes up 60 to 70 percent of the complex; Arvada soil in slightly depressional, sparsely vegetated spots makes up most of the rest.	Beckton clay loam. Arvada clay loam.
Bd	Beckton-Danvers clay loams.	On nearly level to gently sloping high benches. Beckton soil makes up 50 to 70 percent of the complex; Danvers clay loam makes up most of the rest.	Beckton clay loam. Danvers clay loam.
Bf	Beckton-Savage complex	On terraces. Beckton soil makes up 50 to 70 percent of the complex; Savage soil intermingled throughout and makes up most of the rest.	Beckton loam. Savage silty clay.
Bg	Blaine-Spring Creek loams, 2 to 8 percent slopes.	On slopes of 2 to 8 percent in gently rolling uplands. Spring Creek loam on knolls and rises and makes up 15 to 20 percent of the complex; Blaine soil in the area surrounding knolls and rises.	Blaine loam. Spring Creek loam.
Bh	Blaine-Spring Creek stony loams.	On hilly uplands. Spring Creek soil on the prominent knobs and ridges and makes up 30 to 50 percent of the complex; Blaine soil in area between ridges and knolls.	Blaine stony loam. Spring Creek stony loam.
Cc	Castle complex	On 15 to 35 percent slopes of slide areas. Castle clay makes up 70 to 80 percent of the complex. Rest is unnamed reddish clay loam and small areas of Cheadle, Duncom, and Spring Creek soils.	Castle clay.
Cf, Cg	Chama-Midway clay loams.	On slopes of 4 to 15 percent on rolling uplands. Midway soil on knolls and ridges and makes up 20 to 40 percent of the complex; Chama soil in area between ridges and surrounding knolls.	Chama clay loam. Midway clay loam.
Ch	Cheadle-Big Timber-Rock outcrop complex.	On plateau edges and canyon walls. Cheadle soil adjoins rock ledges and makes up 40 to 70 percent of the complex; Big Timber soil on steep slopes between rock ledges and makes up 10 to 30 percent; Rock outcrop makes up the rest.	Cheadle stony loam. Big Timber clay loam.

TABLE 9.—*Key for use with table 8 in obtaining estimated physical and chemical properties in soil complexes and undifferentiated soil groups*—Continued

Map symbols	Soil complexes and undifferentiated soil groups	Soil sites and percentages of main soils	Main soil types
Cr	Cheadle-Rock outcrop complex.	On very steep slopes that are broken by ledges of sandstone. Rock outcrop makes up 30 to 50 percent, and Cheadle soil makes up most of the rest.	Cheadle stony loam.
Cs	Cheadle-Duncom-Rock outcrop complex.	On steep, irregular slopes that are broken by ledges of sandstone and limestone. Cheadle and Duncom soils are between the ledges and make up 50 to 70 percent of the complex; Rock outcrop and areas of deeper soils make up the rest.	Cheadle stony loam. Duncom stony loam.
Cv	Colvin-Lamoure clay loams.	On nearly level to gently sloping terraces. Colvin and Lamoure soils each make up 40 to 60 percent of the complex; Colvin soils tend to occupy the slightly higher areas.	Colvin clay loam. Lamoure clay loam.
Cx	Cowood-Rock outcrop complex.	On steep and very steep mountainous slopes. Slopes broken by outcrops of igneous rock that make up 30 to 40 percent of the complex; Cowood and similar soils make up the rest.	Cowood stony loam.
Dm, Dn, Do	Danvers-Judith clay loams.	On nearly level to gentle slopes on benches. Judith soil occurs on slight rises and gentle slopes; Danvers soil predominates and is in area surrounding the rises.	Danvers clay loam. Judith clay loam.
Dp	Danvers-Judith gravelly clay loams, 0 to 2 percent slopes.	On nearly level to gentle slopes of high benches. Judith soil generally on gentle slopes and slight rises; Danvers soil in the nearly level areas and on some of gentle slopes. Each makes up 40 to 60 percent of the complex.	Danvers cobbly clay loam. Judith gravelly clay loam.
Dt	Darret-Cheadle complex, 2 to 8 percent slopes.	On gently rolling uplands. Cheadle soil on small ridges and knolls and makes up 20 to 50 percent of the complex; Darret soil in area between knolls and ridges and makes up most of the rest.	Darret clay loam. Cheadle channery loam.
Du	Darret-Cheadle complex, 8 to 35 percent slopes.	On steep to moderate slopes of rolling uplands. Cheadle soil on ridges and crests and makes up 20 to 30 percent of the complex; Darret soil on slopes below and between ridges and crests.	Darret clay loam. Cheadle stony loam.
Dv	Darret-Utica complex	On steep slopes of gravel-capped benches. Utica soils on crests and higher slopes and Darret soil on mid and lower slopes. Each makes up 40 to 60 percent of the complex.	Darret clay loam. Utica gravelly loam. Utica stony loam.
Dy	Duncom-Rock outcrop complex.	On steep mountainous slopes and canyon walls. Duncom soil makes up more than 50 percent of the complex; rock cliffs and ledges make up the rest.	Duncom stony loam.
Dz	Duncom-Skaggs-Rock outcrop complex.	On steep and very steep slopes broken by outcrops of limestone and shale that make up 20 to 30 percent of the complex; Duncom and Skaggs soils, in about equal amounts, make up most of the rest.	Duncom stony loam. Skaggs stony clay loam.
Fa	Fargo-Hegne silty clays	On nearly level to gently sloping valley floors. Hegne soil in the outer fringe and on slight rises of the interior and makes up 20 to 40 percent of the complex; Fargo soil makes up the rest.	Fargo silty clay. Hegne silty clay.
Gd	Gallatin soils, wet	On nearly level slopes. Gallatin loam and clay loam that have a higher water table than is normal for Gallatin soils.	Gallatin clay loam. Gallatin loam.
Gr	Gallatin and Raynesford loams.	On nearly level and gently sloping areas along drainageways. Gallatin soil in nearly level lower lying areas and Raynesford soil on gentle slopes. The percentage composition of the two soils varies greatly.	Gallatin clay loam. Raynesford loam.
Hu	Hughesville-Duncom complex.	In steeply rolling, mountainous areas. Duncom soil on ridges, knolls, and crests of drainage slopes and makes up 20 to 30 percent of the complex; Hughesville soils in thickly wooded area.	Hughesville loam. Hughesville stony loam. Duncom stony loam.
Ja	Judith-Ashuelot gravelly loams, 0 to 4 percent slopes.	On nearly level to gentle slopes of high benches. Ashuelot soil makes up 30 to 50 percent of the complex; Judith soil makes up the rest.	Judith gravelly clay loam. Ashuelot gravelly loam.
Jp	Judith-Danvers gravelly clay loams, 0 to 4 percent slopes.	On gentle slopes along drainageways and on irregular, gentle and nearly level slopes of benches. Judith soil on rises, crests, and some of the gentle slopes; Danvers soils in swales and on concave slopes.	Judith gravelly clay loam. Danvers gravelly clay loam. Danvers cobbly clay loam.

TABLE 9.—*Key for use with table 8 in obtaining estimated physical and chemical properties in soil complexes and undifferentiated soil groups*—Continued

Map symbols	Soil complexes and undifferentiated soil groups	Soil sites and percentages of main soils	Main soil types
Jr, Js	Judith and Raynesford stony loams.	On gentle to moderately sloping fans. The percentage composition of the two soils varies greatly.	Judith stony loam. Raynesford stony loam.
Jt	Judith and Savage soils	On moderately sloping fans. Judith soils on upper part of fans and Savage soil on lower part. The percentage composition varies.	Judith clay loam. Judith gravelly clay loam. Savage clay loam.
Ju, Jv	Judith-Utica gravelly loams.	On slopes of 4 to 15 percent on bench edges and the side slopes of drainageways. Utica soils on crests and convex slopes and generally make up less than 50 percent of the complex; Judith soil on slopes below crests and makes up most of the rest.	Judith gravelly clay loam. Utica gravelly loam.
La	Lismas-Pierre clays	In sharply rolling areas. Lismas soil occupies 40 to 60 percent of the complex and is on ridges and steeper slopes; Pierre soil is on the lower and lesser slopes and makes up most of the rest.	Lismas clay. Pierre clay.
Lc	Lismas-Shale outcrop complex.	On steep hilly breaks. Barren shale on steeper slopes and makes up 40 to 70 percent of complex; Lismas soil on lesser slopes and makes up most of the rest.	Lismas clay.
Ls	Loberg-Sapphire complex	On steep and moderately steep slopes of mountainous area. Sapphire soil is in higher areas over sandstone and makes up 30 to 40 percent of complex; Loberg soil is on the lower slopes and makes up most of the rest.	Loberg stony loam. Sapphire loam. Sapphire stony loam.
Mb	Maginnis-Absarokee channery clay loams.	On steep and moderately steep slopes in rolling areas. Maginnis soil on crests and knolls and makes up 60 to 80 percent of complex; Absarokee soil is in swales on lower slopes and makes up the rest.	Maginnis channery clay loam. Absarokee clay loam.
Mc	Maginnis-Alder channery clay loams.	In steep hilly uplands. Maginnis soil on the knolls, ridges, and crests and makes up 60 to 80 percent of complex; Alder soil on side slopes and makes up most of the rest.	Maginnis channery clay loam. Alder clay loam.
Mx	Midway-Shale outcrop complex.	On steep and very steep slopes broken by outcrops of shale and sandstone that make up 20 to 30 percent of complex; Midway clay loam makes up most of the rest and is in areas between outcrops.	Midway clay loam.
Ra, Rd Rf	Raynesford and Adel loams.	On fans and foot slopes having a gradient of 8 to 15 percent. Percentage composition of the two soils varies, but Adel soils are dominant on lower slopes.	Raynesford loam. Adel loam.
Rn	Raynesford and Adel stony loams, 4 to 15 percent slopes.	On fans and foot slopes having a gradient of 4 to 15 percent. Percentage composition of the two soils varies.	Raynesford stony loam. Adel stony loam.
Ro	Rhoades-Arvada complex	In gently rolling uplands. Arvada soil in slight depressions and the Rhoades soil in higher areas. About equal parts of both soils and not less than 40 percent of either.	Rhoades loam. Arvada clay loam.
Sb	Sapphire soils	On moderate to steep mountain slopes Sapphire loam and stony loam. Percentage composition of two soils varies.	Sapphire loam. Sapphire stony loam.
Sc	Sapphire-Cheadle complex	On slopes of 8 to 35 percent in hilly areas. Cheadle soil on grassed knolls and ridges and makes up 30 to 40 percent of complex; Sapphire soil is in wooded areas on side slopes and makes up most of the rest.	Sapphire loam. Cheadle stony loam.
Sp	Skaggs-Cheadle complex	On slopes of 8 to 35 percent in hilly areas. Cheadle soil on knolls and ridges and makes up 25 to 50 percent of complex; Skaggs soil is on slopes below ridges and knolls and makes up 50 to 75 percent.	Skaggs loam. Cheadle stony loam.
Sr	Skaggs-Duncom stony clay loams.	In steep and moderately steep uplands. Duncom soil on ridges, crests, and part of tilted area; Skaggs soil is on lesser slopes. Each makes up 40 to 60 percent of complex.	Skaggs stony clay loam. Skaggs clay loam. Duncom stony loam.
Ss	Skaggs-Raynesford loams, 8 to 35 percent slopes.	Rolling, rough, mountainous slopes of 8 to 35 percent. Skaggs soils on convex parts are dominant; Raynesford soil on fans, in coves, and on foot slopes makes up most of the rest.	Skaggs stony clay loam. Skaggs clay loam. Raynesford loam.

TABLE 9.—*Key for use with table 8 in obtaining estimated physical and chemical properties in soil complexes and undifferentiated soil groups*—Continued

Map symbols	Soil complexes and undifferentiated soil groups	Soil sites and percentages of main soils	Main soil types
St	Skaggs-Duncom-Hughesville complex.	On moderate to steep, rough slopes in mountainous areas. Skaggs soils in parklike areas on moderate slopes; Duncom soil on sides of sharp coulees and in parts of open areas; Hughesville soil in thick patches of timber; Skaggs and Hughesville soils each make up 30 to 40 percent of complex and Duncom soil 20 to 30 percent.	Skaggs clay loam. Skaggs stony clay loam. Duncom stony loam. Hughesville stony loam.
Sv	Spring Creek-Blaine stony loams.	On slopes of 8 to 35 percent in hilly uplands. Spring Creek soil on sharp ridges, knolls, and crests; Blaine soil on side slopes and area between ridges and knolls. Each makes up 40 to 60 percent of complex.	Spring Creek stony loam. Blaine stony loam.
Th	Teton-Adel stony loams	On rough slopes of 8 to 35 percent in foothills. Teton soil on convex parts and makes up 50 to 60 percent of complex; Adel soil in sags, swales, and on small fans and makes up most of the rest.	Teton stony loam. Adel stony loam.
Tk	Teton-Cheadle channery loams, 4 to 15 percent slopes.	On 4 to 15 percent slopes of rolling uplands. Cheadle soil on knolls and ridges and makes up 25 to 40 percent of the complex; Teton soil on the side slopes and area between knolls and ridges and makes up most of the rest.	Teton channery loam. Cheadle channery loam.
Tm, Tn	Teton-Cheadle stony loams.	On rough slopes ranging from 4 to 35 percent. Cheadle soil on ridges, crests, and some of the milder slopes; Teton soils between ridges and below crests. Teton soils are dominant.	Teton stony loam. Teton loam. Cheadle stony loam.
Ug	Utica-Judith gravelly loams, sandy substratum.	On gently undulating terraces. Utica soils on the higher, convex parts; Judith soils in the lower areas between the convex parts. Each makes up 40 to 60 percent of the complex.	Utica gravelly loam. Judith loam. Judith gravelly loam.
Uh	Utica-Judith stony loams	On slopes of 2 to 8 percent in narrow dissected areas along drainageways. Utica soils on edges of old stream channels and on bars; Judith soils on the gentle slopes. Each makes up 40 to 60 percent of the complex.	Utica stony loam. Judith cobbly clay loam. Judith stony clay loam.
Wk	Winifred-Judith clay loams	On bench edges and in rolling areas that have slopes of 4 to 15 percent. Judith soils on upper slopes of bench edges and on bench remnants and make up 20 to 40 percent of the complex; Winifred soil on the lower slopes and makes up 60 to 80 percent.	Winifred clay loam. Judith clay loam. Judith gravelly clay loam.
Wm	Winfred-Rhodes clay loams.	On short foot slopes of 2 to 8 percent. Winifred soil on convex parts and makes up 50 to 60 percent of the complex; Rhoades soil in swales and depressional spots and makes up most of the rest.	Winifred clay loam. Rhoades clay loam.
Wn	Winifred-Utica clay loams	On 15 to 35 percent slopes on bench edges. Utica soils mainly on the steep crests and make up 20 to 50 percent of the complex; Winifred soil on the mid and lower slopes and makes up most of the rest.	Winifred clay loam. Utica gravelly loam.
Wp	Woodhurst-Alder stony complex.	On slopes of 4 to 35 percent in rough uplands. Woodhurst soil on ridges, mounds, and small rounded hills; Alder soils in the intermingled lower areas. Each makes up 40 percent or more of the complex.	Woodhurst stony loam. Alder clay loam. Alder stony clay loam.
Wr	Woodhurst-Loberg complex.	On slopes of 15 percent or more in hilly areas. Loberg soil in thickly wooded part and makes up 50 to 60 percent of complex; Woodhurst soil on the steeper slopes in grassed areas intermingled throughout and makes up most of the rest.	Woodhurst stony loam. Loberg stony loam.
Ws	Woodhurst-Spring Creek stony complex.	On slopes of 8 percent and more on choppy foothills; Spring Creek soil on the ridges, crests, and parts of hills; Woodhurst soil on the lower slopes, in saddles, and in swales. Each makes up more than 40 percent of the complex.	Woodhurst stony loam. Spring Creek stony loam.
Wt	Woodhurst-Teton-Cheadle soils.	On smooth, steep, rounded slopes of mountains. Woodhurst soil is over igneous rock and makes up 30 to 40 percent of complex; Teton and Cheadle soils are over sandstones. Teton soil makes up 25 to 35 percent, and Cheadle soil 20 to 30 percent.	Woodhurst stony loam. Teton stony loam. Cheadle stony loam.

TABLE 10.—

[Tests performed by Bureau of Public Roads (BPR) in accordance with standard procedures of the American Association of State
sampled in

Soil name and location	Parent material	Bureau of Public Roads report No.	Depth	Horizon	Moisture-density [1]		Mechanical analysis [2]		
					Maximum dry density	Optimum moisture	Percentage passing sieve—		
							3-in.	2-in.	1½-in.
			Inches		*Lb. per cu. ft.*	*Percent*			
Terrad clay:									
700 ft. E., 200 ft. N. of NE. corner of SE¼, sec. 12, T. 17 N., R. 8 E. (Modal).	Red shale (Kootenai formation).	S 34264	0–3½	A1	84	30	--------	--------	100
		S 34265	11–23	B22	99	22	--------	--------	--------
		S 34266	55–65	C	96	25	--------	--------	--------
600 ft. W., 200 ft. N. of SE. corner, sec. 7, T. 17 N., R. 9 E. (Modal).	Red shale (Kootenai formation).	S 34267	0–4	A	87	28	--------	--------	--------
		S 34268	9–16	B	93	25	--------	--------	--------
		S 34269	49–59	C	105	19	--------	--------	--------
Terrad clay:									
1,050 ft. S., 1,400 ft. W. of NE. corner, sec. 18, T. 17 N., R. 9 E. (Shallow).	Red shale (Kootenai formation).	S 34270	0–4	A	101	21	--------	--------	--------
		S 34271	4–10	B21	110	18	--------	--------	--------
		S 34272	23–37	C	110	18	--------	--------	--------
Judith loam:									
0.2 mile N. of SE. corner of SW¼, sec. 15, T. 15 N., R. 14 E. (Modal).	Alluvium over very thick beds of limestone gravel.	S 33361	4–8	B2	100	21	--------	--------	--------
		S 33362	18–33	Dca	121	13	100	98	90
		S 33363	44–60	C	134	7	100	95	88
Judith silt loam:									
Triangular area of grass in right-of-way, 1 mile S. of Moccasin. (Modal).	Alluvium over very thick beds of limestone gravel.	S 33364	4–10	B2	96	23	--------	100	99
		S 33365	21–36	Cca2	112	17	--------	100	90
		S 33366	48–60	C	133	8	95	85	80
Judith clay loam:									
450 ft. W., 178 ft. S. of NE. corner, sec. 33, T. 17 N., R. 12 E. (Shallow).	Old alluvium.	S 34273	0–4½	Ap	102	20	--------	--------	100
		S 34274	10–14	B3ca	99	24	--------	--------	100
		S 34275	19–24+	C	133	8	100	96	76
Danvers clay loam:									
110 ft. E., 75 ft. N. of SW. corner of NE¼, sec. 21, T. 19 N., R. 13 E.	Alluvium or loess over stratified alluvium.	S 33352	1½–4	A12	102	20	--------	--------	--------
		S 33353	8–14	B22	100	23	--------	100	99
		S 33354	17–27	Cca1	106	21	--------	--------	100

[1] Based on AASHO Designation: T 99–57, Methods A and C (*1*).

[2] Mechanical analysis according to AASHO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

Engineering test data

Highway Officials (AASHO) (*1*). All samples except those of Danver clay loam sampled in Judith Basin Area; Danvers clay loam Fergus County]

Mechanical analysis [2]—Continued												Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued								Percentage smaller than—							
1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
98	98	96	94	93	91	89	80	76	60	42	32	53	18	A-7-5(14)	MH.
-------	------	100	99	98	97	97	91	87	72	57	50	58	33	A-7-6(20)	CH.
-------	------	------	------	------	------	100	99	97	84	68	50	63	33	A-7-5(20)	MH-CH.
-------	------	------	------	100	98	93	81	76	61	43	34	50	20	A-7-5(14)	ML-CL.
-------	------	------	------	100	99	97	91	89	79	65	58	62	35	A-7-6(20)	CH.
-------	------	------	------	------	------	100	99	98	94	87	70	60	34	A-7-6(20)	CH.
-------	100	99	98	97	95	94	92	90	78	54	42	46	21	A-7-6(14)	ML-CL.
-------	100	99	94	94	91	90	88	87	79	51	38	45	21	A-7-6(13)	CL.
-------	------	------	------	------	------	100	99	98	91	85	66	46	22	A-7-6(14)	CL.
--------	100	98	96	94	89	84	73	68	52	38	30	42	17	A-7-6(11)	ML-CL.
76	66	44	33	29	25	23	18	14	11	9	8	25	7	A-2-4(0)	GM-GC.
76	63	40	27	19	14	11	7	6	4	3	2	18	3	A-1-a(0)	GP-GM.
98	97	95	93	91	88	84	76	71	54	36	26	46	19	A-7-6(13)	ML-CL.
84	81	75	71	68	65	61	52	48	39	31	26	35	15	A-6(5)	CL.
67	57	36	24	18	15	13	8	7	4	3	2	19	3	A-1-a(0)	GP-GM.
98	97	93	90	86	78	72	60	54	40	27	21	38	14	A-6(7)	ML-CL.
96	92	86	81	77	71	66	57	54	45	35	29	46	18	A-7-6(8)	ML-CL.
65	54	38	29	22	11	7	4	4	2	1	1	[4] NP	[4] NP	A-1-a(0)	GP.
100	99	97	95	94	91	88	78	71	52	34	25	37	15	A-6(10)	CL.
99	99	98	97	96	94	92	84	77	60	42	36	48	23	A-7-6(15)	CL.
99	99	98	97	96	93	89	82	68	58	48	41	41	20	A-7-6(12)	CL.

[3] Based on the Unified Soil Classification System, Tech. Memo. No. 3-357, v. 1, Waterways Experiment Station, Corps of Engineers, March 1953. Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within 2 points from A-line are to be given a borderline classification.

[4] NP means nonplastic.

TABLE 11.—*Engineering*

Soil series or type and map symbols [1]	Suitability as source of—			Soil features affecting—		
	Topsoil	Gravel	Road fill	Highway location	Farm ponds	
					Reservoir	Embankment
Absarokee clay loam and Absarokee loam (Aa, Ab, Ad, Af, Ag, Ah, Mb).	Good in upper 8 inches; poor below.	Not suitable	Fair to poor	Heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential; moderate stability; high compressibility.
Absarokee silty clay (Ac).	Fair in upper 5 inches; poor below.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High shrink-swell potential; fair to poor stability.
Adel (Ak, Al, Am, Ra, Rd, Rf, Rn, Th).	Good in upper 30 inches.	Not suitable	Poor in upper 30 inches; fair to good below.	High content of organic matter in upper 30 inches.	High content of organic matter in upper 30 inches.	High content of organic matter in upper 30 inches.
Alder (An, Ao, Ap, Ar, As, Mc, Wp).	Good in upper 12 inches; poor below.	Not suitable	Poor in upper 12 inches.	Heave by frost action high.	No unfavorable features.	High content of organic matter in upper 12 inches; poor stability; high compressibility.
Arvada (At, Au, Av, Aw, Bc, Ro).	Poor	Not suitable	Very poor	High dispersion; high erodibility; heave by frost action high.	No unfavorable features.	High dispersion; poor stability; susceptible to piping.
Ashuelot (Ax, Ja)	Poor	Good for road subbase; poor for concrete.	Good below cemented layer.	No unfavorable features.	Rapid permeability.	Rapid permeability
Bainville (Ba)	Fair	Not suitable	Fair	Heave by frost action moderate.	Shallow to stratified soft sandstone and soft shale.	Poor stability; high erodibility; high compressibility.
Beckton (Bb, Bc, Bd, Bf, At, Au).	Good in upper 5 or 6 inches; not suitable below.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High dispersion; subject to piping; high shrink-swell potential.
Big Timber (Ch)	Poor	Not suitable	Fair to poor	Heave by frost action high; steep slopes.	Shallow to pervious bedrock.	Shallowness
Blaine (Bg, Bh, Sv)	Good in upper 6 inches; poor below.	Not suitable	Fair to poor	Heave by frost action moderate.	Moderately deep to bedrock.	No unfavorable features.
Blythe (Bk, Bm)	Good in upper 14 inches; not suitable below.	Not suitable	Poor	High content of organic matter in upper 14 inches; heave by frost action high.	No unfavorable features.	High shrink-swell potential.
Bowdoin (Bo)	Poor	Not suitable	Poor	Imperfect drainage; slow permeability; high shrink-swell potential; heave by frost action high.	No unfavorable features.	Moderate to poor stability; high compressibility; high shrink-swell potential.
Bridger loam (Bp, Br)	Good in upper 8 inches; fair between 8 and 15 inches.	Not suitable	Poor in upper 8 inches; fair between 8 and 15 inches; good below 15 inches.	No unfavorable features.	Moderate to rapid permeability in gravelly substratum.	Moderate to rapid permeability in gravelly substratum.

See footnote at end of table.

interpretations for soils

Soil features affecting—Continued						
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites
Moderate permeability; moderately deep to bedrock.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate permeability and moderate depth to bedrock are severe limitations.	Moderate to high shrink-swell potential; fair bearing capacity.
Moderately deep to bedrock.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	Moderately slow permeability.	Slow permeability, moderate depth to bedrock, and clay content are severe limitations.	High shrink-swell potential; fair bearing capacity.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Poor bearing capacity to a depth of 30 inches.
Moderately deep to bedrock.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate permeability and moderate depth to bedrock are severe limitations.	Moderate shrink-swell potential; fair bearing capacity.
Slow permeability	High dispersion; slow permeability.	Dispersed clays near the surface.	High dispersion; high content of salt.	High erodibility; high dispersion.	Slow permeability, high dispersion, and corrosiveness are severe limitations.	High dispersion; high shrink-swell potential; heave by frost action high.
No unfavorable features.	Cemented hardpan near the surface.	Cemented layer near the surface.	Shallowness; rapid permeability.	Shallowness-----	No unfavorable features.	No unfavorable features.
Not applicable----	Not applicable--	Not applicable--	Shallowness-----	Susceptibility to erosion; shallowness.	Bedrock near the surface is a severe limitation.	Fair bearing capacity and shear strength.
Slow permeability; poor stability.	Slow permeability; moderate alkalinity and salinity in the subsoil.	Highly dispersed clay near the surface.	High dispersion; moderate alkalinity and salinity in the subsoil.	High dispersion; high erodibility.	Slow permeability, high dispersion, and corrosiveness are severe limitations.	High shrink-swell potential; highly dispersed subsoil.
Not applicable----	Not applicable--	Not applicable--	Shallowness-----	Shallowness-----	Slow percolation in bedrock is a severe limitation.	Moderate shrink-swell potential.
Moderately deep to bedrock.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate depth to bedrock is a severe limitation.	No unfavorable features.
Slow permeability; poor stability.	Slow permeability.	Shallow to dispersed clay.	Poor stability---	No unfavorable features.	Slow permeability and clay content of soil are severe limitations.	High shrink-swell potential.
Slow permeability.	Slow permeability.	No unfavorable features.	No unfavorable features.	Moderate to poor stability.	Slow permeability, clay content of soil, and occasional flooding are severe limitations.	High shrink-swell potential.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.

TABLE 11.—*Engineering*

Soil series or type and map symbols [1]	Suitability as source of—			Soil features affecting—		
	Topsoil	Gravel	Road fill	Highway location	Farm ponds	
					Reservoir	Embankment
Bridger stony loam (Bs)	Good to fair in upper 8 inches.	Not suitable	Poor in upper 8 inches; fair between 8 and 15 inches; good below 15 inches.	No unfavorable features.	Rapid permeability in gravelly substratum.	Rapid permeability in gravelly substratum.
Castle (Ca, Cb, Cc)	Fair in upper 6 inches; poor below.	Not suitable	Poor	Heave by frost action high; poor stability.	No unfavorable features.	High shrink-swell potential; poor stability.
Chama (Cd, Cf, Cg)	Good in upper 8 inches; fair between 8 and 30 inches.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	Moderately deep to shale.
Cheadle loam (Cn, Co)	Good in upper 4 inches; poor below.	Not suitable	Fair to poor	Shattered sandstone near the surface.	Shallow to shattered sandstone.	Shallowness
Cheadle stony loam and channery loam (Ch, Ck, Cm, Cp, Cr, Cs, Ad, Af, Ag, Dt, Du, Sc, Sp, Tk, Tm, Tn, Wt).	Poor	Not suitable	Not suitable	Shallow to fractured sandstone.	Shallow to fractured sandstone.	Shallowness
Cobbly alluvial land (Cu).	Not suitable	Good	Good	Susceptibility to flooding.	Very rapid permeability.	Very rapid permeability; high content of gravel and sand.
Colvin (Cv)	Fair in upper 12 inches; not suitable below.	Not suitable	Poor	Poor drainage; heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential in upper 36 inches; moderate stability; high compressibility.
Cowood (Cw, Cx)	Poor	Good for road subbase; not suitable for concrete.	Good	No unfavorable features.	Rapid permeability.	Rapid permeability
Danvers (Da, Db, Dc, Dd, Df, Dg, Dh, Dk, Dm, Dn, Do, Dp, Bd, Jp).	Good in upper 12 inches; fair to poor between 12 and 30 inches; not suitable below 30 inches.	Not suitable in upper 30 inches; good below for road subbase.	Poor in upper 30 inches; good below.	No unfavorable features.	No unfavorable features.	Moderate shrink-swell potential; fair stability; medium to high compressibility; rapid permeability in substratum.
Darret (Dr, Ds, Dt, Du, Dv).	Good in upper 4 inches; fair between 4 and 24 inches.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential; fair to poor stability; fair compactibility.
Dimmick (Dw)	Poor; high content of clay.	Not suitable	Poor	Susceptibility to flooding; heave by frost action high.	No unfavorable features.	High shrink-swell potential; poor stability; high compactibility.
Duncom (Dx, Dy, Dz, Cs, Hu, Sr, St).	Poor	Not suitable	Poor	Shallow to bedrock.	Shallow to bedrock.	High content of organic matter in surface layer; shallow soil.

See footnote at end of table.

interpretations for soils—Continued

Soil features affecting—Continued						
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites
No unfavorable features.	Stoniness	Stones and cobblestones throughout soil.	Stones and cobblestones throughout soil.	Stones and cobblestones throughout soil.	No unfavorable features.	No unfavorable features.
Slow permeability; moderate depth to shale.	Slow permeability; moderate depth to shale.	High content of clay; slow permeability; moderate depth to shale.	Slow permeability.	Slow permeability; fair to poor stability.	Slow permeability is a severe limitation.	High shrink-swell potential.
Moderately deep to clay loam shale.	Moderately deep to shale.	Moderately deep to shale.	No unfavorable features.	No unfavorable features.	Slow percolation in shale at moderate depth is a severe limitation.	Moderate shrink-swell potential.
Not applicable	Not applicable	Not applicable	Shallowness	Shallowness	Shattered sandstone near the surface is a severe limitation.	No unfavorable features.
Not applicable	Not applicable	Not applicable	Shallowness	Shallowness	Shattered sandstone near the surface is a severe limitation.	No unfavorable features.
No unfavorable features.	Very low moisture-storage capacity.	High content of stones and cobblestones; very low moisture-storage capacity.	High content of cobblestones, stones, pebbles, and sand.	High content of cobblestones, stones, pebbles, and sand.	Very rapid permeability and susceptibility to flooding are severe limitations.	Subject to flooding.
Perched water table caused by shale at depth of 5 to 10 feet.	Water table 1 to 5 feet below surface.	No unfavorable features.	No unfavorable features.	Water table 1 to 5 feet below surface.	Water table 1 to 5 feet below surface is a severe limitation.	Water table 1 to 5 feet below surface; moderate shrink-swell potential.
Not applicable	Not applicable	Not applicable	Not applicable	Shallowness	Shallowness is a severe limitation.	No unfavorable features.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.
Moderately deep to shale.	Moderately deep to shale.	Moderately deep to shale.	No unfavorable features.	No unfavorable features.	Moderately slow permeability and shale at moderate depth are severe limitations.	Moderate shrink-swell potential.
Very slow permeability; no outlet in most places.	Susceptibility to flooding.	High content of clay; susceptibility to flooding.	High content of clay; susceptibility to flooding.	Periodic flooding.	Very slow permeability and clay content of soil are severe limitations.	High shrink-swell potential; periodic flooding.
Not applicable	Not applicable	Not applicable	Not applicable	Bedrock near the surface; stones in surface layer.	Slow percolation in bedrock is a severe limitation.	No unfavorable features.

TABLE 11.—*Engineering*

Soil series or type and map symbols [1]	Suitability as source of—			Soil features affecting—		
	Topsoil	Gravel	Road fill	Highway location	Farm ponds	
					Reservoir	Embankment
Fargo (Fa)	Poor; high content of clay.	Not suitable	Poor	Poor drainage; heave by frost action high.	No unfavorable features.	High shrink-swell potential; poor stability.
Fergus clay loam (Fc, Fd, Ff, Fh).	Good in upper 6 inches; fair below.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential; high compressibility.
Fergus silty clay loam, shale substratum (Fs).	Good in upper 6 inches; fair between 6 and 20 inches.	Not suitable	Poor to fair	Heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential; fair to poor stability; fair compactibility.
Gallatin loam and clay loam (Ga, Gb, Gd, Gr).	Good	Not suitable	Poor to fair	Imperfect drainage; heave by frost action moderate.	No unfavorable features.	Medium to high compressibility; moderate stability; high content of organic matter.
Gallatin loam, clay substratum (Gc).	Good in upper 12 inches; poor below.	Not suitable	Poor	Poor drainage; heave by frost action high.	No unfavorable features.	High shrink-swell potential; fair stability.
Hegne (Fa)	Poor; high content of clay.	Not suitable	Poor	Poor drainage; heave by frost action high.	No unfavorable features.	High shrink-swell potential; poor stability.
Hughesville (Hu, St)	Poor	Not suitable	Poor	Hard bedrock at 18 to 30 inches.	Moderately deep to pervious bedrock.	Moderate depth; moderate shrink-swell potential; bedrock moderately deep below the surface.
Judith clay loam (Jb, Jc, Jd, Jf, Dm, Dn, Do, Wk).	Good in upper 5 inches; fair between 5 and 10 inches; poor below 10 inches.	Not suitable in upper 30 inches; good for road subbase below.	Fair to poor in upper 30 inches; good below.	Heave by frost action high.	Rapid permeability below a depth of 30 inches.	No unfavorable features.
Judith cobbly clay loam, Judith gravelly clay loams, and Judith gravelly loam (Ja, Jh, Jk, Jl, Jm, Jn, Jo, Jp, Jr, Js, Jt, Ju, Jv, Dp, Ug, Uh).	Fair in upper 5 to 10 inches; poor below.	Not suitable for concrete; good for road subbase if mixed.	Good	No unfavorable features.	Rapid permeability below a depth of 24 inches.	Rapid permeability
Lamoure (Cv)	Fair in upper 12 inches; poor below.	Not suitable	Poor	Poor drainage; heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential in upper 36 inches; moderate stability; high compressibility.
Laurel (Av)	Not suitable	Not suitable	Not suitable	High dispersion; high erodibility; heave by frost action high.	No unfavorable features.	High dispersion; poor stability; susceptibility to piping.

See footnote at end of table.

interpretations for soils—Continued

Soil features affecting—Continued						
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites
Very slow permeability.	Poor drainage; very slow permeability.	High content of clay.	High content of clay.	High content of clay.	Very slow permeability and poor drainage are severe limitations.	High shrink-swell potential; poor drainage.
Moderate permeability.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderate permeability and clay content of soil are severe limitations.	Moderate shrink-swell potential.
Shale at a depth of 30 to 40 inches.	Shale at a depth of 30 to 40 inches.	Shale at a depth of 30 to 40 inches.	No unfavorable features.	No unfavorable features.	Moderate permeability, shale substratum, and clay content of soil are severe limitations.	Moderate shrink-swell potential.
No unfavorable features.	Imperfect drainage.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Seasonally high water table and occasional flooding are severe limitations.	Imperfect drainage; moderate or low shrink-swell potential.
Very slow permeability below a depth of 12 inches.	Water table at a depth of 2¼ to 4 feet; very slow permeability below 12 inches.	Water table at a depth of 2½ to 4 feet; clay at 12 inches.	Water table at a depth of 2½ to 4 feet.	High water table.	High water table and very slow permeability below 12 inches are severe limitations.	Poor drainage; high shrink-swell potential.
Very slow permeability.	Poor drainage; very slow permeability.	High content of clay.	High content of clay.	High content of clay.	Very slow permeability and poor drainage are severe limitations.	Very slow permeability; poor drainage.
Not applicable----	Not applicable--	Not applicable--	Stoniness; steep slopes.	Stoniness; steep slopes.	Bedrock at moderate depth is a severe limitation.	No unfavorable features.
No unfavorable features.	No unfavorable features.	High lime concentration near the surface.	No unfavorable features.	Very gravelly substratum below a depth of 30 inches.	No unfavorable features.	Moderate shrink-swell potential in upper 30 inches of soil.
No unfavorable features.	Limited depth for storing moisture.	High lime concentration near the surface; moderately deep to gravel.	No unfavorable features.	Very gravelly substratum below a depth of 30 inches.	No unfavorable features.	No unfavorable features.
Perched water table caused by shale at a depth of 5 to 10 feet.	Water table 1 to 5 feet below surface.	No unfavorable features.	No unfavorable features.	Water table 1 to 5 feet below surface.	Water table 1 to 5 feet below surface is a severe limitation.	Poor drainage; moderate shrink-swell potential in upper 36 inches.
High dispersion; slow permeability.	High dispersion; slow permeability.	High dispersion; slow permeability.	High dispersion.	High dispersion; high content of salt.	High dispersion, slow permeability, and clay content of soil are severe limitations.	High shrink-swell potential; high dispersion; heave by frost action high.

TABLE 11.—*Engineering*

Soil series or type and map symbols [1]	Suitability as source of—			Soil features affecting—		
	Topsoil	Gravel	Road fill	Highway location	Farm ponds	
					Reservoir	Embankment
Lismas (La, Lc)	Not suitable	Not suitable	Poor	Poor stability; heave by frost action high.	Clay shale near the surface.	Moderate shrink-swell potential; poor stability.
Little Horn (Lh)	Fair in upper 6 inches; stones in surface layer.	Not suitable	Poor	Heave by frost action moderate.	Moderately deep to pervious bedrock.	Moderate shrink-swell potential; moderately deep to bedrock.
Loberg (Lr, Ls, Wr)	Fair in upper 12 inches; poor below.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	Moderate shrink-swell potential; moderate to poor stability.
Maginnis (Ma, Mb, Mc, Ah, Ar, As).	Fair to poor in upper 6 inches.	Not suitable	Fair to good	No unfavorable features.	Shallow to pervious bedrock.	Shallow to bedrock
Midway (Cf, Cg, Mw, Mx).	Poor	Not suitable	Poor to fair	Heave by frost action moderate.	Shallow to shale	Shallowness; moderate shrink-swell potential.
Pierre (Pc, Pd, La)	Poor	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High shrink-swell potential; fair to poor stability.
Promise (Pm, Po, Pp, Pr).	Fair	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High shrink-swell potential; fair to poor stability.
Raynesford (Rf, Rn, Gr, Jr, Js, Ra, Rd, Ss).	Good in upper 12 inches; fair below.	Not suitable	Poor in upper 12 inches; fair to poor below.	High content of organic matter in upper 12 inches.	High content of organic matter in upper 12 inches.	High content of organic matter in upper 12 inches.
Rhoades (Ro, Wm)	Fair in upper 6 inches.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	Fair to poor stability; high shrink-swell potential.
Sapphire (Sb, Sc, Ls)	Fair to poor	Not suitable	Poor	Heave by frost action moderate.	Moderately deep to pervious bedrock.	Moderately deep to bedrock.
Savage silty clay (Bf, Sd, Se, Sf).	Good in upper 5 inches; poor below.	Not suitable	Poor	Heave by frost action moderate or high.	No unfavorable features.	Moderate to high shrink-swell potential; moderate stability; high compressibility.
Savage silty clay loam (Sg, Sh, Sk, Jt).	Good in upper 5 inches; fair below.	Not suitable	Poor	Heave by frost action moderate.	No unfavorable features.	Moderate stability; high compressibility.
Skaggs (Sl, Sm, Sn, So, Sp, Sr, Ss, St, Dz).	Good in upper 8 inches.	Not suitable	Poor	Heave by frost action moderate.	Moderately deep to pervious bedrock.	High content of organic matter in upper 7 inches; moderately deep to bedrock.
Slocum (Su)	Good in upper 16 inches; fair below.	Not suitable	Poor in upper 16 inches; high content of organic matter.	High content of organic matter; imperfect drainage.	No unfavorable features.	High content of organic matter in upper 16 inches.

See footnote at end of table.

interpretations for soils—Continued

Soil features affecting—Continued						
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites
Not applicable	Not applicable	Not applicable	Shallow to shale.	Shallow to shale.	Slow permeability and shale near the surface are severe limitations.	High shrink-swell potential.
Stones throughout; moderately deep to bedrock.	Stones throughout; moderately deep to bedrock.	Stones throughout; moderately deep to bedrock.	Stones throughout soil.	Stones throughout soil.	Slow to moderate percolation in bedrock is a moderate or severe limitation.	No unfavorable features.
Moderately slow permeability.	Moderately slow permeability.	Shallow to clay	No unfavorable features.	No unfavorable features.	Moderately slow permeability is a severe limitation.	High shrink-swell potential.
Not applicable	Not applicable	Not applicable	Shallow to bedrock.	Shallow to bedrock.	Bedrock near the surface is a severe limitation.	No unfavorable features.
Not applicable	Not applicable	Not applicable	Shallowness	Shallowness	Moderately slow permeability and shallowness to shale are severe limitations.	Moderate shrink-swell potential.
Slow permeability	Slow permeability; poor workability.	Moderately deep to shale; clay texture.	No unfavorable features.	Slow permeability.	Slow permeability, clay content of soil, and shale at moderate depth are severe limitations.	High shrink-swell potential.
Slow permeability	Slow permeability.	Slow permeability.	No unfavorable features.	Slow permeability.	Slow permeability and clay content of soil are severe limitations.	High shrink-swell potential.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderate permeability is a moderate limitation.	Fair to poor bearing capacity.
Slow permeability	Slow permeability.	Moderately dispersed clay subsoil	Very slow permeability.	No unfavorable features.	Very slow permeability and moderate depth to bedrock are severe limitations.	High shrink-swell potential; fair bearing capacity.
No unfavorable features.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate percolation in bedrock is a moderate or severe limitation.	No unfavorable features.
Moderately slow permeability.	Moderately slow permeability.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderately slow permeability and clay content of soil are severe limitations.	High shrink-swell potential; fair bearing capacity.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderate permeability and clay content of soil are severe limitations.	Moderate shrink-swell potential; fair bearing capacity.
Moderately deep to bedrock.	Moderately deep to bedrock.	Moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate depth to bedrock is a severe limitation.	No unfavorable features.
Fluctuating water table.	Fluctuating water table.	No unfavorable features.	Fluctuating water table.	No unfavorable features.	Water table fluctuating between depths of 3 to 5 feet is a severe limitation.	Imperfect drainage.

TABLE 11.—*Engineering*

Soil series or type and map symbols [1]	Suitability as source of—			Soil features affecting—		
	Topsoil	Gravel	Road fill	Highway location	Farm ponds	
					Reservoir	Embankment
Spring Creek (Sv, Bg, Bh, Ws).	Poor	Not suitable	Good	Shallow to bedrock.	Shallow to pervious bedrock.	Not applicable
Straw clay loam (Sw, Sx).	Good in upper 8 inches; fair below.	Not suitable	Poor	Heave by frost action moderate.	No unfavorable features.	Poor stability; high compressibility.
Straw clay loam, gravelly substratum (Sy).	Good in upper 8 inches.	Not suitable	Poor in upper 24 inches; good below.	No unfavorable features.	Rapid permeability below 24 inches.	Rapid permeability below a depth of 24 inches.
Terrad clay (Ta, Tb, Aw).	Fair	Not suitable	Poor	Heave by frost action high.	All features favorable.	High shrink-swell potential; poor stability; high compressibility.
Terrad silty clay (Tc)	Fair	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High shrink-swell potential; poor stability; high compressibility.
Teton (Td, Tf, Th, Tk, Tm, Tn, Wt).	Good	Not suitable	Poor in upper 9 inches; fair to good below.	High content of organic matter in upper 9 inches.	Moderately deep to bedrock.	High content of organic matter in upper 9 inches; moderately rapid permeability.
Twin Creek (To, Tp, Tr, Tw).	Good in upper 10 inches; fair below.	Not suitable	Fair to poor	Heave by frost action moderate.	No unfavorable features.	Moderate shrink-swell potential; high compressibility.
Utica (Ua, Ub, Ug, Uh, Dv, Ju, Jv, Wn).	Poor	Good for road subbase or gravel surface.	Good	No unfavorable features.	Rapid permeability.	Rapid permeability.
Winifred (Wb, Wc, Wd, Wf, Wh, Wk, Wm, Wn).	Fair in upper 8 inches; poor below.	Not suitable	Poor	Heave by frost action high.	No unfavorable features.	High shrink-swell potential; high compressibility; poor stability.
Woodhurst (Wo, Wp, Wr, Ws, Wt).	Poor; very stony.	Not suitable	Good	Many stones	Rapid permeability.	Rapid permeability

[1] Symbols in parentheses are those of the mapping units, including complexes and undifferentiated soil groups, in which soils of the series or type occur.

interpretations for soils—Continued

Soil features affecting—Continued						
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites
Not applicable	Not applicable	Shallowness; stones in surface soil.	Shallowness	Shallowness	Bedrock near the surface is a severe limitation.	No unfavorable features.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderate permeability and clay content of soil are severe limitations.	Moderate shrink-swell potential.
No unfavorable features.	Moderately deep over gravel; moderate moisture-storage capacity.	Moderately deep to coarse material.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.
Moderately slow permeability; moderately deep to shale.	Moderately slow permeability; moderately deep to shale.	Moderately deep to shale.	No unfavorable features.	High content of clay.	Moderately slow permeability and clay content of soil are severe limitations.	High shrink-swell potential.
Moderately slow permeability.	Moderately slow permeability.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderately slow permeability and clay content of soil are severe limitations.	High shrink-swell potential.
Deep or moderately deep to bedrock.	Deep or moderately deep to bedrock.	Deep or moderately deep to bedrock.	No unfavorable features.	No unfavorable features.	Moderate or rapid percolation in bedrock is a moderate limitation.	No unfavorable features.
No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderate permeability and clay content of soil are moderate limitations.	Moderate or low shrink-swell potential.
No unfavorable features.	High content of gravel; low moisture-storage capacity.	Thin surface layer; high content of gravel; low moisture-storage capacity.	Rapid permeability.	Low moisture-storage capacity.	No unfavorable features.	No unfavorable features.
Moderately slow permeability.	Moderately slow permeability; deep or moderately deep to salts in shale.	Deep or moderately deep to shale.	No unfavorable features.	No unfavorable features.	Moderately slow permeability is a severe limitation.	Moderate or high shrink-swell potential.
Not applicable	Not applicable	Not applicable	Stoniness	Stoniness	Stoniness and moderate depth to bedrock are severe limitations.	No unfavorable features.

Emphasis is on those features that have an adverse effect on the engineering uses of the soils.

The descriptions and the profiles given in table 8 were used in estimating the suitability of the soils in table 11 for topsoil, gravel, and road fill, and in determining the features that affect engineering structures and features. Because there may be variations from these profiles, the ratings of soils for some uses may differ somewhat from the ratings listed in table 11.

Formation and Classification of Soils

This section consists of four main parts. The first part discusses the factors of soil formation and tells how these factors have influenced the formation of soils in the survey area. The second part describes the soil order, or highest category in the system of soil classification, and the great soil groups represented in the survey area. It also lists the soil series in their respective soil orders and their great soil groups. The third part, in alphabetic order, describes each soil series in the survey area, including a profile typical of the series. The fourth part gives the results of physical and chemical analyses of selected soils.

Factors of Soil Formation

Soils are mixtures of weathered rock and minerals, organic matter, water, and air, each of which vary in the different soils. The major factors that interact in the formation of soils are (1) parent material, (2) climate, (3) plant and animal life, particularly plant life, (4) topography, or lay of the land, and (5) time. The characteristics of a soil at any given place are determined by the interaction of these five factors.

Parent material

Figure 18 shows that several geologic formations are exposed in the survey area. These formations range in age from Mississipian to Quaternary. In addition, alluvium has been laid down recently in the valleys. Many kinds of parent material weathered from these formations. The formations represent seven geologic periods that can be grouped in the Pretertiary, Tertiary, Quaternary, and Recent periods.

Pretertiary.—Many soils in the foothills and mountainous areas and in the rolling areas of the plains section developed in place from materials that were deposited on the bottom of what was once a great sea. If, referring to figure 18, we start with Colorado shale, which is in the plains section, and go downward through the formations and upward in elevation to the mountains, we see several kinds of shale, sandstone, siltstone, and limestone, all of which formed from sediments deposited during the Pretertiary period. From these materials, many different kinds of soils developed.

Tertiary.—Figure 18 indicates that the Woodhurst, Loberg, and Cowood soils developed in place from igneous rock. Although not shown in figure 18, other soils in the survey area also developed in place from igneous rock. Igneous rock formed from molten materials that pushed to or near the surface during the Tertiary period when the crust of the earth was highly disturbed by volcanic action. During this period Pretertiary materials were pushed up to approximately their present elevation.

Quaternary.—Quaternary deposits make up benches, or broad alluvial plains, and also the lower terraces of the basin proper. Geologists have grouped these benches and terraces into five levels according to their elevations. The material of the younger, lower terraces was deposited by present streams. The pebbles and cobblestones underly-

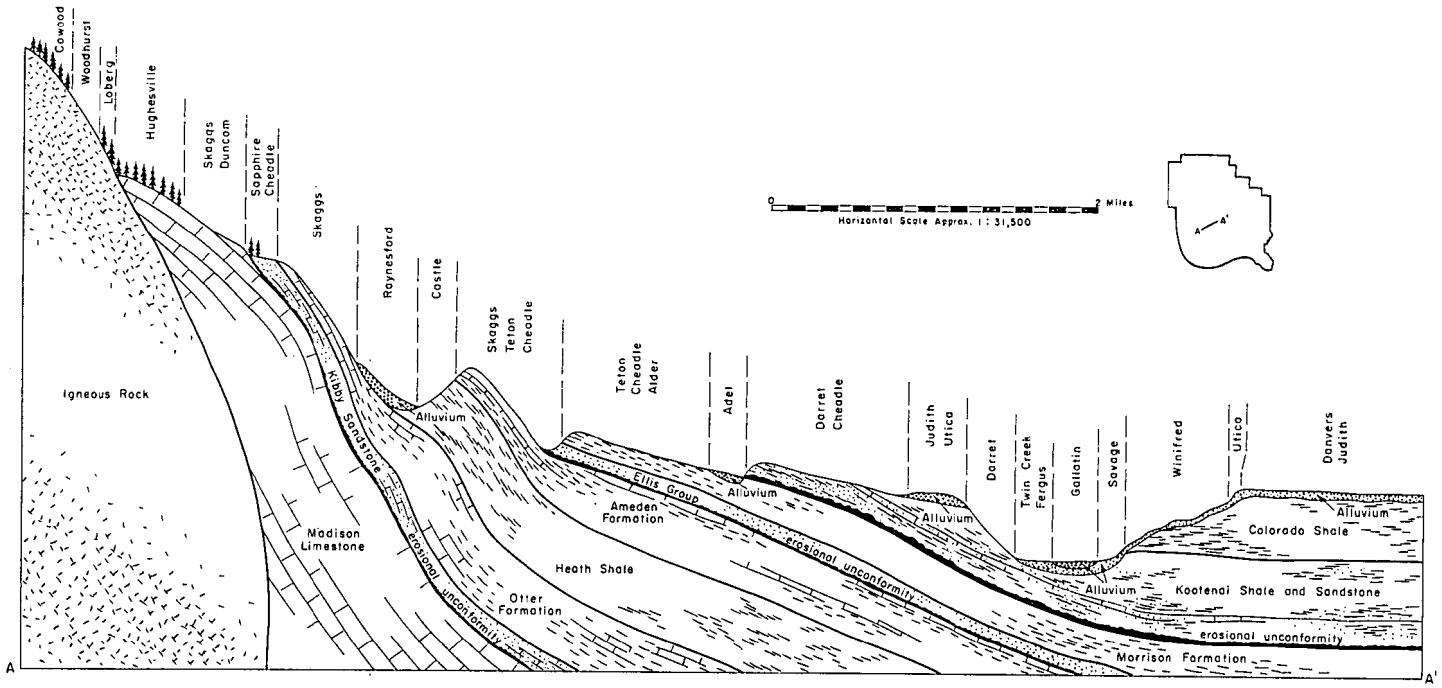

Figure 18.—**Relation of soils in survey area to geologic formations and to one another.**

ing the soils of the high benches, or broad alluvial plains, were deposited by former, larger streams that flowed from the Little Belt and Highwood Mountains and from the Big Snowy Mountains, in Fergus County, and converged in the Judith Basin (*16*). In a few areas nearly all the pebbles and cobblestones are igneous rock, but in most places they are mixed and consist mainly of limestone and partly of igneous rock, sandstone, and quartzite. The parent material of the soils overlying the pebbles and cobblestones is dominantly clay loam alluvium that washed from the uplands, but it includes some windblown material.

Recent.—Recent deposits have been deposited by the streams that exist today. This alluvium consists of loam, clay loam, and clay, as well as small amounts of very cobbly or very gravelly sandy loam or loamy sand. The thickness of the material varies. In a few places the soils formed from this alluvium are underlain by shale at a depth of 4 to 6 feet, but in most places shale is at a depth of more than 15 feet. These soils are subject to varying degrees of flooding. Some of them have a high water table. They have very little horizonation, though the material is stratified in many areas.

Climate

As stated in the section "General Nature of the Survey Area," the climate in the survey area is continental and is greatly affected by topography. The Little Belt Mountains adjoin the survey area on the southwest and the Highwood Mountains on the northwest, and both ranges greatly influence the amount of annual precipitation and the length of the growing season in the survey area. Generally, the higher the elevation, the greater the annual precipitation and the shorter the growing season (table 12).

TABLE 12.—*Elevation, annual precipitation, and number of frost-free days in physiographic areas*

Physiographic area	Elevation	Annual precipitation	Frost-free days
	Feet	*Inches*	*Number*
Little Belt Mountains	6,000 to 9,000	22 to 34	80 to 90
Highwood Mountains	5,000 to 7,000	22 to 26	90 to 95
Foothills	4,500 to 6,000	18 to 22	95 to 105
Plains section	3,700 to 4,500	14 to 18	100 to 120

The greater part of the Little Belt Mountains is 7,000 to 9,000 feet above sea level, and the greater part of the Highwood Mountains is 5,000 to 7,000 feet. The elevation of the plains section is 4,199 feet at Stanford and 4,300 feet at Moccasin, but the elevation falls to about 3,700 feet in some of the drainageways in the northeastern part of the survey area.

The average annual precipitation at Kings Hill is around 28.5 inches. Although Kings Hill is in Cascade County, and outside of the survey area, the precipitation there is indicative of that in the Little Belt Mountains. The average annual precipitation at Stanford was 15.16 in the period from 1928 through 1958. At Moccasin the average was 14.79 inches from 1909 through 1958. Annual precipitation, therefore, ranges from about 14 inches to almost 30 inches in the survey area.

Consecutive freeze-free days in the high mountains have not been recorded, but they are estimated to range from 75 to 90 days. At Stanford the average number of days between the last freeze in spring and the first in fall is 104 days, whereas at Denton, Fergus County, this average is 132 days. Denton is farther from the mountains than Stanford and about 4 miles outside of the survey area.

These differences in annual precipitation and in temperature affect the kinds of soils that form in the survey area. Directly or indirectly through the influence of climate, there are wide differences in the color of the surface layer, amount of organic matter, and thickness of soil horizons.

Plant and animal life

Grasses, shrubs, trees, micro-organisms, earthworms, and other forms of plants and animals live on and in the soils and are active in the soil-forming processes. The micro-organisms decompose plant residue and by so doing help to form organic matter and affect the chemistry of the soils. Plant nutrients are converted into a form available to higher plants, and the higher plants, in turn, produce more residue for micro-organisms to work on. Thus, the micro-organisms and higher forms of plant life are interdependent. The amounts and kinds of organisms that live naturally in any given soil are determined by the other interacting factors of soil formation. The influence of climate is most apparent, but climate affects the formation of soil largely through living organisms.

Burrowing animals, such as moles, influence the formation of soils by mixing their upper layers.

More than 90 percent of the survey area originally was covered by grasses. The only sizable areas in trees were high in the foothills and in the mountains.

Grasses lessen the leaching of the basic elements in the soil by using nearly all of the precipitation that falls and thus preventing moisture from penetrating deep in the profile. The depth that moisture penetrates is determined partly by the roots of grass, but also by the kind of soil material and the amount of precipitation. Through a period of time, clay is taken downward by water and increases the content of clay in the subsoil, or B2 horizon. Also, lime accumulates immediately below the subsoil in a normal soil. The organic matter produced by roots and the grass above the surface helps in forming the granular and crumb surface horizon and the blocky and prismatic structure of the subsoil that are typical of normal soils in grasslands.

Trees grow naturally in areas where rainfall is higher than in grasslands, or where there is adequate moisture in the soil at depths greater than those generally reached by grass roots. Where the moisture penetrates to depths reached by the deep roots of trees, grasses give way to trees. The water takes the clay deeper in the profile, thicker subsoils are formed, and plant nutrients are leached to greater depths. Less organic matter is produced by trees than by grass because trees lack dense, fibrous root systems. If lime occurs, it is moved downward and the soils become acidic. Thus trees, as well as grass, play a distinct role in forming soils with clearly expressed horizons.

Topography

The topography of the survey area varies greatly. Slopes range from nearly level to steep, and areas are rolling, hilly, rough and broken, or mountainous. This varied topography modifies the effect of climate and influences the kinds of vegetation that grow.

The contrast in vegetation that results from the varied topography is particularly noticeable when the trees growing in the foothills on short, steep, north-facing slopes are compared with the grasses on the south slopes. The north slopes are shaded by the hills for a longer time than the south slopes and receive direct sunlight for a shorter time. Snow melts on the north slopes more slowly, less moisture is lost through evaporation, and more of it penetrates deeper in the soil and permits deeper soil development and leaching. On the north slopes, therefore, more moisture is available for plants, and trees instead of grasses grow naturally. Also affecting soil formation on the north slopes are the downward tilting geologic formations that permit seepage in some places.

Much water runs off some of the steep slopes and highly convex areas, and snow blows from the more exposed places. In these areas geologic erosion almost keeps pace with the weathering of rock and the formation of soils. Other than a thin, dark surface horizon and layers below with accumulated lime, genetic horizons do not form. The Cheadle, Duncom, Midway, and Spring Creek soils formed under such conditions.

But definite genetic horizons are formed where soils receive additional runoff. The soils in swales and in concave areas that receive runoff from higher ground have thicker and darker surface horizons than soils that do not receive this runoff. In addition, they have thicker and generally finer textured subsoils and a greater depth to accumulated lime. Not only does the additional water help from these horizons, but it deposits soil particles washed from higher, steeper soils. Examples of soils that receive additional runoff are those in the Adel, Twin Creek, Bridger, and Savage series.

Time

Time, measured in hundreds and thousands of years, is necessary for the formation of soils. Long periods are needed for the rocks to break down physically and for them to be changed by chemical reaction and microorganisms in the formation of parent material. Then, additional long periods are needed for the soils to form from the parent material. The length of time required for the development of a soil depends on other factors. The degree of profile development, for example, depends on the intensity of other soil-forming factors, the length of time these factors have been acting, and the nature of the materials from which the soil formed.

The soils formed in recent alluvium along the present streams have little or no genetic horizonation. They are young soils because the soil-forming factors have not had enough time to develop definite profile characteristics.

The soils that formed on low terraces are a little older than those that formed on stream bottoms. The Straw and Twin Creek soils formed on low terraces and have faint to distinct horizons. Still older soils are those of the Absarokee and Danvers series. The Absarokee soils formed in uplands, and the Danvers soils formed on high benches. Both have distinct horizons.

Classification of Soils

This subsection briefly explains the soil classification system generally used in the United States and lists the soil series of the survey area in their respective soil orders and great soil groups. It describes the three soil orders in the classification system and the great soil groups represented in the survey area. Several of the soil series in the great soil groups are discussed.

Soils are classified into categories that progressively become more inclusive. In the United States a natural classification system is used that consists of classes or groups in six categories. Starting at the top, the categories are the order, suborder, great soil group, family, series, and type.

The highest category consists of three orders, and in the lowest category thousands of soil types are recognized. The suborder and family have not been fully developed and, therefore, have been little used. Attention has been directed largely toward great soil groups, series, and types. Groups in the highest category are the zonal, intrazonal, and azonal orders.

Each great soil group consists of several or many soil series that have the same general kind of profile. Within the same great soil group, however, the soils of different series have different kinds of parent material and different degrees of development.

Soil series and types are defined in the section "How Soils Are Mapped and Classified." The list that follows places the soil series of the Judith Basin Area in their respective soil orders and great soil groups.

Order and great soil group	*Series*
Zonal—	
Chestnut	Absarokee, Big Timber (intergrading toward Lithosols), Blaine, Chama, Danvers, Darret, Fergus, Maginnis (intergrading toward Lithosols), Pierre, Promise, Savage, Straw, Terrad, Twin Creek, Winifred.
Chernozem	Adel, Alder, Bridger, Gallatin (intergrading toward Alluvial soils), Little Horn, Slocum (intergrading toward Alluvial soils), Teton, Woodhurst.
Gray Wooded	Cowood (intergrading toward Lithosols), Hughesville, Loberg, Sapphire.
Intrazonal—	
Calcisol	Ashuelot, Judith, Raynesford, Skaggs.
Grumusol	Castle, Fargo.
Humic Gley	Dimmick, Lamoure.
Planosol	Blythe.
Solonchak	Colvin, Hegne, Laurel.
Solonetz	Arvada, Beckton, Rhoades.
Azonal—	
Alluvial	Bowdoin, low clay variant (intergrading toward Grumusols).
Lithosol	Bainville, Cheadle, Duncom, Lismas, Midway, Spring Creek.
Regosol	Utica.

Zonal soils

The Zonal soils have well-defined profile characteristics that reflect the influence of the active forces of soil formation, climate, and living organisms. These forces have acted on the parent material for a long time but have not been subjected to extreme conditions of relief and drainage. Lime has been removed from the A1 and B2 horizons and has accumulated in a horizon below. The Zonal soils in this survey area are Chestnut soils, Chernozems, and Gray Wooded soils.

CHESTNUT SOILS

The Chestnut soils of this survey area have thin to moderately thick grayish-brown to dark grayish-brown A horizons, blocky or prismatic-blocky B horizons, and horizons of calcium carbonate accumulation that generally start at a depth of 10 to 24 inches and grade to less calcareous C or R horizons. These soils occupy the plains section and the lower foothills and developed in materials that range from loam to clay. The parent materials are alluvium and materials weathered in place from shale, sandstone, and basic igneous rock. These soils developed in a cool, moist, semiarid climate. The vegetation was mid grass in which bunch grasses dominated. Soils representative of this great soil group occur on nearly level and gently sloping fans, terraces, and high benches and in rolling uplands.

The distinctness of horizons differs in the soils that developed from the same or similar kinds of parent material, as well as in the soils that developed from different kinds. The Pierre, Promise, Straw, and Twin Creek soils have a darkened A horizon, a color or structural B horizon, and a horizon of lime accumulation. These characteristics indicate little change from the parent material other than an increase in organic matter in the surface horizon, a downward movement of calcium carbonate, and a slight chemical change that resulted in the formation of a color or a structural B horizon. The Danvers, Fergus, and Savage soils developed in similar but older material than did the Pierre, Promise, Twin Creek, and Straw soils and have more clearly expressed horizons. In addition to the changes mentioned for the Pierre, Promise, Straw, and Twin Creek soils, the Danvers, Fergus, and Savage soils have distinctly more clay in the B2 horizon than in the A and C horizons and have a more pronounced accumulation of calcium carbonate. The Absarokee soils have even more clay in the B2 horizon. They are believed to have developed partly in alluvium and windblown materials but mainly in residuum weathered in place from hard shale and sandstone. The B2 horizon of Absarokee soils is generally clay, and the A horizon is loam or clay loam. These soils generally do not have a C horizon, but where there is one, it is strongly calcareous clay loam.

Zonal characteristics, therefore, are expressed minimally in the Straw and Twin Creek soils, medially in the Danvers, Fergus, and Savage soils, and maximally in the Absarokee soils. The differences between the minimal and medial expressions can be attributed largely to the length of time the material has been exposed to the climate and organisms, whereas the difference between the medial and maximal expressions can be attributed to the differences in composition of the parent material.

CHERNOZEMS

Chernozems have a thick or moderately thick, very dark colored to black surface horizon that is high in organic-matter content and grades to a lighter colored, blocky subsoil. The subsoil grades to a layer of lime accumulation.

The Chernozems of this survey area occur at high elevations in the grasslands of the foothills and mountains. They developed in loam and clay loam. The parent material consists of alluvium and material weathered in place from shale, sandstone, limestone, and igneous rock. These soils developed in a cool, subhumid climate where the vegetation was mixed tall and mid grasses. The soils representative of this great soil group occur on the rolling uplands and on gently or moderately sloping fans.

Horizons in the Chernozems are thicker than corresponding horizons in the Chestnut soils, and the A horizon is darker colored. The A horizon of Chernozems is typically dark gray or very dark grayish brown when dry and black when moist. The thick or moderately thick B horizon has blocky or prismatic structure. In some profiles of Alder and similar soils, the B horizon extends to the underlying bedrock and there is no C horizon. The calcium carbonate has moved down and out of the profile in most areas. The Bridger and Little Horn soils, however, have a faint to distinct Cca horizon.

The degree of horizon expression differs considerably for the different soil series in the Chernozem great soil group. This difference can be attributed partly to the age and partly to the composition of the soil material. The Gallatin soils are Chernozems that intergrade toward Alluvial soils. They have a thick, black surface layer that is underlain by a slightly lighter colored subsoil. The Adel and Teton soils have a thick, black A horizon and a color or structural B horizon, but there has been little change in the parent material except a marked increase of organic matter in the surface layer and patches of clay on the peds of the B horizon. The B horizon is generally higher in chroma than the A horizon. In some profiles of Teton soils, clay has slightly increased in the B horizon. The increase in clay has been greater in the B horizon of the Bridger and Woodhurst soils, and that horizon contains distinctly more clay than the A and C horizons. Furthermore, the Bridger soils are browner in the B horizon than in the A horizon and have a distinct accumulation of calcium carbonate below the B horizon. In Alder soils on uplands, the clay content of the B horizon is even more than that of the Bridger and Woodhurst soils. The texture of the B2 horizon of Alder soils is clay or silty clay, whereas that of the A horizon is clay loam. Because the B2 horizon generally extends to the underlying bedrock, there is no C horizon. Free lime has moved down and accumulated in the bedrock.

Zonal characteristics are expressed minimally in the Adel, Gallatin, and Teton soils, medially in the Bridger and Woodhurst soils, and maximally in the Alder soils. Since the material from which Chernozems developed is only slightly different in texture and mineral composition, the difference in degree of horizon expression can be attributed to a combination of differences in age and kinds of material.

Soils in the Alder series can be compared with soils in the Absarokee series, which are Chestnut soils. The soils of these two series developed in place from material weathered from interbedded hard shale and sandstone

mixed with some alluvium and windblown material. For the two series, all factors of soils formation except climate and living organisms have been the same. In the Alder soils these factors produced a very dark color that extends from the surface to a depth of 8 to 15 inches and indicates a high content of organic matter. In the Absarokee soils the surface layer is lighter colored, and this lighter color does not extend even to a depth of 8 inches. Because the other factors of soil formation were the same in the Alder and Absarokee soils, the differences in the soils can be attributed to the effects of climate and living organisms.

GRAY WOODED SOILS

The Gray Wooded soils developed from varied parent material under a forest cover. Their profiles have (1) a thin layer of forest litter and humus; (2) a grayish A2 horizon that is slightly acid to medium acid and contains an abundance of bleached silt and sand grains; and (3) a brown, blocky, textural B2t horizon. In addition, Gray Wooded soils have in some places a very thin, dark A1 horizon and generally a transitional A2 and B2 horizon or a B2 and A2 horizon, or both.

This group of soils occurs in the mountains and in some parts of the higher foothills. Their development has been different from that of the Chestnut soils and Chernozems of the grasslands. A favorable combination of climate, soil material, and moisture content permitted conifer seedlings to take root, grow to maturity, and furnish a forest cover. The fallen needles and twigs from these conifers were decomposed by micro-organisms and formed a thin layer of humus at the surface. Through this mat of forest litter and humus, little of the moisture that entered the soil evaporated. As the micro-organisms decomposed the organic matter, acids were produced. Presumably hydrogen from the acids displaced calcium, and some of the displaced calcium was leached to varied depths. Clay particles, humus, and some of the iron compounds were removed (eluviated) from the upper horizons and were accumulated in the lower horizons. This action caused a graying of the mineral soil of the A2 horizon, just below the humus (*2*). As the leaching and eluviation continued, the bleached mineral soil presumably became thicker and encroached on the upper subsoil to form the A2 and B2 horizon, the B2 and A2 horizon, or both. The clayey subsoil, called the B2t horizon, separated into very distinct blocks on which films of clay formed. Thus, through the processes of leaching and eluviation, which collectively are called podzolization, the Gray Wooded soils were formed. Though some leaching has taken place, the subsoil has retained high base saturation.

The Gray Wooded soils are somewhat similar to Alder and other grassland soils but have a thin layer of humus at the surface, a bleached horizon lacking organic matter near the surface, and a B2t horizon that is lighter brown than that of the Alder soils.

The Loberg and Sapphire soils, though developed in different kinds of parent material, have clearly expressed horizons characteristic of Gray Wooded soils. Below their thin layer of humus there are strikingly grayish mineral horizons that grade to a blocky B2t horizon. Much clay has been transferred from the upper horizons to the lower ones, and the B2t horizon contains distinctly or prominently more clay than the A2 horizon. The translocation of clay from the A2 horizon to the B2 horizon is greater in the Loberg soils than in the Sapphire soils. The Loberg soils developed from moderately fine textured material that weathered from shale, sandstone, and igneous rock, whereas the Sapphire soils developed from loamy material that weathered exclusively from sandstone.

The Cowood and Hughesville soils exemplify this great soil group in their initial stages of development. Because the soils of these two series have extreme differences in morphology, they are discussed separately.

The Cowood soils developed in gravelly loamy material that weathered from extrusive igneous basalt. They have very weakly expressed horizons and are Gray Wooded soils that intergrade toward Lithosols. A layer of forest litter and humus material is at the surface. The removal of iron compounds and clay particles from the top horizons of mineral soil to a lower one and the leaching of calcium is indicated by the acidic reaction, the bleached sand and silt grains in the A2 horizon, the stained and coated sand grains and isolated coated peds in the B2 horizon, and patches of clay films on rock fragments.

The Hughesville soils developed in highly calcareous loam and clay loam material that weathered from limestone and limy shale. They have fairly distinct but thin horizons. Like other Gray Wooded soils, Hughesville soils have a thin layer of forest litter and humus at the surface. The removal of clay particles and iron compounds from the upper horizons to a lower one is indicated by the distinctly gray, very thin A2 horizon and the distinctly higher content of clay in the B2 horizon than in the A2 and C horizons. That calcium is leached to only a slight degree is indicated by the near neutral reaction of the A2 horizon and the absence of free calcium carbonate in the B2 horizon.

Intrazonal soils

Intrazonal soils have profile characteristics that reflect the dominant influence of microclimate, relief, drainage, or parent material, or some other single local factor, over the normal effect of climate and vegetation. Since the controlling factor in the formation of these soils is local, intrazonal soils are distributed widely over the survey area in bodies of varying sizes. In the Judith Basin Area, there are six great soil groups in the intrazonal order.

CALCISOLS

The Calcisols in this survey area are a group of soils having a dark-colored surface horizon that is underlain by a very light colored Cca horizon with high concentrations of calcium carbonate (*4*). These soils developed in strongly calcareous loam to clay loam alluvium or in material weathered in place from limestone, limy shale, or limy sandstone. They occur with both the Chestnut and Chernozem soils. Vegetation is mostly mid grasses and partly mid grasses mixed with tall grasses.

The Judith, Raynesford, and Skaggs soils each has a profile representative of this great soil group. The Judith and Raynesford soils developed in alluvium, and the Skaggs soils developed partly in alluvium and partly in residuum. The soils of all three series occur on convex slopes or on nearly level, even slopes, but not on concave slopes. Lime occurs as coatings of pebbles, as concretions, and as lime flour disseminated throughout the soil mass.

The calcium carbonate equivalent is estimated to range from 10 to 50 percent in the Cca horizon.

GRUMUSOLS

Grumusols developed in material containing a high proportion of clay, generally more than 50 percent. They have weakly expressed or no horizonation below the A horizon. The identifying characteristics of these soils are: (1) the high proportion of clay throughout; (2) deep cracks that form upon drying and swallow surface material; and (3) sheared and polished faces on the structural peds of the subsoil.

The sheared and polished surfaces of the peds, called slickensides or pressure faces, are the result of the movement of one mass of soil against another. This movement is caused by the swelling and shrinking during wetting and drying. These soils swell when they are wet, and they shrink and crack when they dry.

In the Judith Basin Area, the Grumusols are best exemplified in the Castle soils. Castle soils developed in clay weathered from shale. Cracks 1 to 2 inches wide extend into the subsoil when these soils dry after wetting. Castle soils have a dark, granular surface horizon and prominent pressure faces below a depth of 8 to 10 inches. The soil granules fall into the cracks in the dry soil. Thus, the soil is slowly but constantly churned.

HUMIC GLEY SOILS

In the Humic Gley great soil group are poorly drained soils having a darkened A horizon that is underlain by gray gleyed material. These soils are calcareous in some places, but segregated lime occurs within 16 inches of the surface in only a few places, and in these places it occurs in small amounts.

The Humic Gley soils in this survey area are represented by the Dimmick soils, which developed in clay, and by the Lamoure soils, which developed in clay loam. Both Dimmick soils and Lamoure soils have profile characteristics representative of Humic Gley soils. The gray color of these soils is probably the result of intense reduction of the iron compounds that occurs because continuous wetness causes poor aeration. The Lamoure soils are calcareous, and the Dimmick soils are noncalcareous.

PLANOSOLS

In Planosols water has removed clay from the surface horizon and has redeposited enough of it to form a B horizon that is denser or more compact than the B horizon of associated zonal soils (*14*).

Blythe soils are the only Planosols in the survey area. They are in a subhumid climate in the foothills. They developed on fans in alluvium and on rolling uplands in material that weathered in place from shale and sandstone. The removal of clay from the surface layer is indicated by the thick, nearly black, loamy A1 horizon and the columnar, clay B2t horizon. The bleached material in the A2 horizon further indicates leaching of clay minerals, of iron, and of aluminum, or of all three.

SOLONCHAK SOILS

Most Solonchak soils developed under imperfect or poor drainage in areas where the water table fluctuated or was permanently high (*13*). In this survey area Colvin and Hegne soils are of this kind. They are more representative of the Solonchak great soil group than are the Laurel soils, which also are in the survey area. Laurel soils developed under moderately good drainage.

Representative Solonchak soils have a moderately thick, black, calcareous A horizon that grades to a light-colored Cca horizon, generally within 20 inches of the surface. Gleying and mottling are evident in Solonchak soils, particularly in the ones that formed under poor drainage. In areas of these soils the ground water generally contains a considerable amount of lime in solution. Evidently, the prominent Cca horizon formed when lime was precipitated out of the capillary water that rose or moved laterally from a zone of water saturation (*11*).

The Colvin soils in the survey area developed in silty clay loam, and the Hegne soils developed in clay. The A horizon of both soils has been darkened by the organic matter that accumulated from the abundant water-tolerant plants. The light-colored subsoil has an intense accumulation of lime that is uniformly disseminated through the subsoil in faint to distinct segregations. The lower subsoil is gleyed and mottled to varying degrees. This gleying is the result of a lack of oxidation.

Laurel soils are the only moderately well drained Solonchak soils in the survey area. They are very strongly saline. Laurel soils developed in stratified clay and clay loam. Their A2 horizon is very thin, and their B2 horizon is blocky. Segregations of salts occur throughout the profile below a depth of 2 to 6 inches.

SOLONETZ SOILS

Solonetz soils have a friable surface horizon of variable thickness that is underlain by dark, hard soil material that ordinarily is columnar in structure. Many of these soils are highly alkaline throughout, but some horizons may be neutral or even acid. Solonetz soils formed under grass or shrub vegetation, mainly in a subhumid or semiarid climate.

In the survey area Solonetz soils occur mainly in the plains section. Their surface layer is thin and friable and because some of the mineral compounds have been leached from it, it is nearly neutral or acid. Furthermore, by a process called solodization, clay and some sodium and other salts have been leached from the B2 horizon so that it is less dense and less alkaline than the B2 horizon in Solonetz soils that have not been solodized.

In the survey area the Arvada soils are Solonetz soils that have been solodized. They have an A horizon of thin, light-colored, slightly acid loam that is abruptly underlain by a columnar clay B2t horizon. Horizons of accumulated lime and other salts also occur. The upper part of the B2t horizon is almost neutral, and the lower part of the B2 horizon is moderately alkaline. The strongly alkaline B2 horizon of the Beckton soils and the accumulated salts just below it indicate that these soils have been leached of salts less than have the Arvada soils. The Rhoades soils on uplands have a clay subsoil that varies in salt content but, as a whole, is nearly neutral or slightly alkaline. Little or no salts other than calcium carbonate have accumulated in Rhoades soils.

Azonal soils

Azonal soils have weakly expressed, very thin horizons or no horizons at all. These soils reflect the effect of local

relief, or of time that has not been long enough for genetic horizons to form. All three great soil groups in the azonal order—Alluvial soils, Lithosols, and Regosols—are represented in this survey area.

ALLUVIAL SOILS

Alluvial soils developed on the flood plains of streams in recently deposited alluvium that has been changed little by the soil-forming processes.

In this survey area Alluvial soils are subject to only occasional flooding and receive little deposition. In recent time they apparently have remained fairly stable and, therefore, are not typical Alluvial soils. In this survey area only Bowdoin, low clay variant, is in this great soil group.

LITHOSOLS

Lithosols consist of shallow to moderately deep soils that weathered in place from weakly consolidated or hard bedrock (*14*). These soils have no horizons or only a thin or weakly expressed A1 horizon or Cca horizon. Consequently, they are much like the bedrock from which they weathered. Lithosols lack development because they occur on steep slopes and in convex areas where runoff is rapid and washes away the soil material almost as fast as it forms.

Among the Lithosols in this survey area are the Cheadle, Duncom, Lismas, and Spring Creek soils. Since these soils have little or no development, their series may be determined by the kind of bedrock from which they developed. The Cheadle soils developed from weathered sandstone; the Duncom soils, from weathered limestone and some interbedded soft shale; the Lismas soils, from weathered clay shale; and the Spring Creek soils, from weathered igneous rock.

REGOSOLS

Regosols developed in deep, unconsolidated material, but they do not have clearly defined horizons. They are generally calcareous at the surface and in some places they have a thin A1 horizon or a weakly expressed horizon of lime segregation. Regosols lack the hard bedrock that is not far from the surface in the Lithosols. Runoff is rapid because slopes are steep or convex, and distinct genetic horizons have not formed.

Utica gravelly loam is a representative Regosol in this survey area. It developed in thick beds of pebbles mixed with material finer than sand.

Technical Descriptions of the Soils

This subsection is provided for those who need more technical information about the soils of the Judith Basin Area than is given in the section "Descriptions of the Soils." The soil series are described in alphabetic order and the descriptions include a detailed profile representative of the series.

ABSAROKEE SERIES

The Absarokee series consists of well-drained Chestnut soils that are on the uplands of the plains and are underlain by bedrock that is moderately deep in the profile. The parent material is loam or clay loam that is believed to be weathered in place from hard shale and sandstone and mixed with some alluvium and windblown material. These soils have a thin, dark-colored A1 horizon and a strong, prismatic and blocky, clayey B2t horizon that has distinct clay films on ped faces. The bedrock is hard shale or sandstone.

The Absarokee soils have a thinner, lighter colored A1 horizon than the Alder soils and are at lower elevations. Alder soils are Chernozems. Absarokee soils are at least 18 inches to bedrock and are deeper than the closely associated Maginnis soils. The Maginnis soils have a very thin B2 horizon or none at all.

Profile of Absarokee clay loam (100 feet west of SE. corner, SE¼NW¼ sec. 21, T. 15 N., R. 13 E., 200 feet east of edge on plateau; in native pasture):

A1—0 to 2½ inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist, slightly sticky and plastic when wet; noncalcareous; abundant roots; pH 7.2; clear boundary.

B21t—2½ to 8 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure that breaks to moderate, very fine, blocky structure; thin, continuous clay films on vertical faces of peds and patches on horizontal faces; slightly hard when dry, friable when moist, very sticky and plastic when wet; abundant roots; noncalcareous; pH 7.4; clear boundary.

B22t—8 to 13 inches, dark grayish-brown (10YR 4/2) clay when dry or moist; strong, fine and very fine, blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; thick, distinct, continuous clay films on all ped faces; pH 7.4; noncalcareous; abundant roots; abrupt boundary.

B23t—13 to 19 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; strong, medium and coarse, prismatic structure that breaks to moderate, medium and coarse, blocky structure; distinct, continuous clay films on all ped faces; pressure faces visible on blocks; extremely hard when dry, very firm when moist; very sticky and very plastic when wet; plentiful flattened roots follow structural planes; noncalcareous; pH 7.6; gradual boundary.

B24t—19 to 26 inches, grayish-brown (2.5Y 4.6/2) clay, dark grayish brown (2.5Y 4/2) when moist; fragments of cherty sandstone make up 5 percent of horizon; strong, medium and coarse, angular blocky structure; thick clay films on ped faces; extremely hard when dry, very firm when moist; very sticky and very plastic when wet; plentiful roots follow structural planes; noncalcareous; pH 7.8; abrupt boundary.

R—26 to 28 inches, dark-gray, light-gray, and rust-colored cherty sandstone that is somewhat fractured by clay between the rocks; clay films on upper side of rocks; lower side of sandstone thinly coated with lime.

Loam, clay loam, and silty clay of the Absarokee series are mapped in the survey area. The clay loam is the most extensive. It developed from material that weathered from thinly stratified hard shale and sandstone. The parent rock of the loam is largely sandstone, but that of the silty clay is dominantly clay shale. The A1 horizon ranges from 2 to 4 inches in thickness. When dry, the A1 horizon is 2.5Y and 10YR in hue, 2 to 1 in chroma, and 4 to 3 in value. Depth to bedrock ranges from 18 to 36 inches but is 18 to 30 inches in most places. These soils are generally noncalcareous throughout, but some of the deeper profiles have just above the bedrock a Cca horizon 4 to 8 inches thick. In some places a thin film of lime coats the underside of the sandstone in the upper layers of the bedrock.

ADEL SERIES

The Adel series consists of well-drained Chernozems that have a thick solum and developed in loamy alluvium on fans and terraces of the foothills. The horizon sequence is (1) a very dark colored A1 horizon about 1 foot thick and (2) a B2 or an AC horizon that is a structural or color horizon, or both. In places where a C horizon occurs, it contains no segregations of lime.

The lack of lime segregations within 16 inches of the surface distinguishes the Adel soils from the Raynesford soils. Adel soils have less clay in their B2 horizon and fewer lime segregations than the Bridger soils. The lime segregations that do occur in the Adel soils are at a greater depth than those in the Bridger soils. Adel soils lack the sandstone substratum of the Teton soils on the uplands. Typical profile of Adel loam (1,100 feet east of center of sec. 21, T. 17 N., R. 8 E.; on east side of drainageway, in native pasture):

A1—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, medium, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; pH 7.0; roots abundant; clear boundary.

A12—6 to 13 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, medium, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; pH 7.2; roots abundant; clear boundary.

B21—13 to 23 inches, dark grayish-brown and very dark grayish-brown (10YR 4/2 and 3/2) heavy loam, very dark brown (10YR 2/2) when moist; weak, fine, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; several krotovinas about 2 inches in diameter; thin, patchy clay films in root holes; pH 7.6; roots plentiful; clear, wavy boundary.

B22—23 to 27 inches, dark grayish-brown (10YR 4/2) very gravelly heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin, patchy clay films on vertical faces of peds; pH 7.6; roots plentiful to few; abrupt boundary.

B23—27 to 42 inches, grayish-brown and gray (10YR 5/2 and 5/1) loam containing several sandstone fragments, dark grayish brown and dark gray (10YR 4/2 and 4/1) when moist; moderate, medium and coarse, blocky structure; many pores; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; patchy clay films on vertical faces of peds; numerous worm casts; noncalcareous; pH 8.2.

The Adel soils commonly occur closely with the Raynesford soils. Silt loam, loam, and stony loam have been mapped in the survey area. The A1 horizon ranges from 8 to 18 inches in thickness. Lime segregations generally do not occur, but in some places there are faint to distinct ones below a depth of 16 inches.

ALDER SERIES

The Alder series consists of well-drained Chernozems that are underlain by bedrock on uplands in the foothills. The depth to bedrock is moderate. The parent material is clay loam that presumably weathered in place from hard shale and sandstone mixed with some alluvium and windblown material. The horizon sequence is (1) a very dark colored A1 horizon 4 to 12 inches thick; (2) a clayey B2t horizon that has strong, prismatic-blocky structure and distinct clay films on ped faces; and (3) bedrock consisting of thinly stratified hard shale and sandstone.

The Alder soils have a thicker, darker colored A1 horizon than the Absarokee soils and a more clayey B2 horizon than the Teton soils.

Typical profile of Alder clay loam (530 feet west of NE., corner of SE¼ sec. 24, T. 18 N., R. 8 E.; in native pasture):

A1—0 to 10 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; moderate, fine, crumb structure in upper few inches and moderate, medium, prismatic structure to moderate, medium and fine, subangular blocky structure below; slightly hard when dry, friable when moist, sticky and plastic when wet; pH 6.1; abundant roots; gradual boundary.

B1—10 to 14 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, prismatic structure and moderate, medium and coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; continuous, distinct clay films on vertical faces and patches on horizontal faces; pH 6.3; plentiful roots; clear boundary.

B2t—14 to 21 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; strong, fine, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all faces of peds; pH 6.4; plentiful roots; gradual boundary.

B3—21 to 27 inches, grayish-brown and light brownish-gray (2.5Y 5/2 and 6/2) silty clay, olive brown and very dark grayish brown (2.5Y 4/4 and 3/2) when moist; moderate, medium, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on vertical faces, and patches on horizontal faces; pH 6.7; few roots.

R—27 inches +, thinly stratified shale and cherty sandstone.

Alder clay loam is the most extensive type in the survey area. Stony clay loam occurs in only a few small areas. When moist, the black A1 horizon has the Munsell notation of 10YR 2/1 or 2/2. Depth to bedrock ranges from 22 to 40 inches. Ordinarily these soils are noncalcareous, but in some deep profiles a Cca horizon occurs just above the bedrock. In some places the undersides of the upper layer of the bedrock are coated with lime.

ARVADA SERIES

The Arvada series consists of Solonetz soils that have a thin surface layer and are solodized. These soils developed in clay or clay loam on stream terraces and fans, in swales of the high benches and, to a lesser extent, on the uplands. The horizon sequence is (1) a thin A2 horizon; (2) a slightly to moderately alkaline B2t horizon; and (3) a Cca or Ccs horizon. The B2t horizon grades to the Cca or Ccs horizon.

The Arvada soils have a lighter colored, thinner surface horizon than the Beckton soils.

Typical profile of Arvada loam (300 feet south and 900 feet east of NW. corner of SW¼ sec. 8, T. 18 N., R. 10 E.; in native grass pasture on 6 percent slope):

A2—0 to 3 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and thin, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; roots abundant; noncalcareous; pH 6.8; abrupt boundary.

B21t—3 to 8 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, columnar structure; material from A2 horizon coats the columns and tongues; very hard when dry, friable when moist, sticky and plastic when wet; distinct clay films on vertical faces; plentiful roots follow the structural seams; pH 7.2; clear boundary.

B22t—8 to 11 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; thick, distinct, continuous clay films on all faces; few roots; pH 8.2; clear boundary.

C1ca—11 to 17 inches, dark grayish-brown and light grayish-brown (2.5Y 4/2 and 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium and fine, blocky structure; hard when dry, friable when moist, very sticky and very plastic when wet; strongly calcareous; many threads, specks, and streaks of lime; pH 8.6; clear boundary.

C2ca—17 to 36 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; massive (horizontal cleavage); hard when dry, friable when moist, very sticky and very plastic when wet; weakly calcareous; few threads of lime; pH 8.8; clear boundary.

C3sa—36 to 46 inches, grayish-brown (2.5Y 5/2 dry or moist) clay loam; massive; soft when dry, friable when moist, sticky and plastic when wet; specks and streaks of fine salt crystals; noncalcareous; pH 7.2; clear boundary.

C4—46 to 70 inches, platy, grayish-brown shale interbedded in clay loam residuum; pH 7.4; noncalcareous.

In this survey area Arvada soils are mapped in complexes with the Laurel, Beckton, and Terrad soils. In places the Arvada soils have an A1 horizon 1 to 2 inches thick, but the A1 horizon does not occur in most places. The A2 horizon ranges from 2 to 3 inches in thickness and from loam to clay loam in texture. The horizons in the subsoil are only slightly or moderately alkaline. Generally, a Cca horizon occurs below the B2t horizon, but in some places there is a calcareous Ccs horizon instead. Ordinarily, a Ccs or Csa underlies the Cca horizon. On uplands shale is at a depth of 20 to 50 inches, and on terraces and benches it is at a depth of more than 5 feet.

ASHUELOT SERIES

The Ashuelot series consists of loamy Calcisols that are shallow and very shallow to caliche. These soils formed in very gravelly, loamy alluvium on high benches. They have a dark-colored, gravelly, loamy A1 horizon and a Cca horizon that is within 20 inches of the surface and is cemented with lime.

The caliche layer distinguishes the Ashuelot soils from the associated Utica and Judith soils.

Typical profile of Ashuelot gravelly loam (100 feet east of NW. corner of NE¼ sec. 17, T. 13 N., R. 14 E., in abandoned field that has reverted to grass):

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) when moist; weak, fine, crumb structure in upper part, and weak, medium, blocky structure in lower 2 inches; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; pH 7.6; clear boundary.

AC—5 to 13 inches, dark grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; strong, coarse, angular blocky structure breaking to moderate, coarse, angular blocky; hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous, but the only segregated lime is that which weakly cements the small pebbles; pH 8.4; clear boundary.

C1ca—13 to 18 inches, light grayish-brown (10YR 5.7/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, blocky structure breaking to fine, angular blocky; hard when dry, firm when moist, very sticky and very plastic when wet; very strongly calcareous; many, medium and large, irregular masses of white lime flour; small pebbles more strongly cemented together than those in horizon above; pH 8.6; clear boundary.

IIC2—18 to 21 inches, light-gray (10YR 7/2) cemented gravel and sand, light brownish gray (10YR 6/2) when moist; massive; strongly calcareous; pH 9.0; abrupt boundary; roots extend to this layer and stop.

IIC3—21 to 30 inches, cobblestones, gravel, and fine earthy material that ranges from loam to sandy clay loam; gravel heavily coated with lime and has little or no cementation; gravel and cobblestones make up 75 percent of the horizon by volume.

Only gravelly loam is mapped in the survey area. It occurs in relatively pure areas and with the Judith soils where it is mapped with them in a complex. When dry, the A1 horizon has a Munsell notation that ranges from 10YR 4/2 to 10YR 5/2. Depth to the caliche generally ranges from 4 to 10 inches, though the caliche is exposed at the surface in spots and is as much as 20 inches from the surface in some places.

BAINVILLE SERIES

The Bainville series consists of light-colored, loamy Lithosols that developed in soft, weakly consolidated, calcareous, loamy shale interbedded with thin layers of sandstone. Only the slightly dark A1 horizon reflects a change from the light color of the calcareous parent material. The horizon sequence normally is an A1 horizon, a C horizon, and a R horizon.

The Bainville soils are not so fine textured as the Midway soils, which developed from clay loam shale.

Typical profile of Bainville loam (920 feet north and 1,000 feet west of center of sec. 12, T. 18 N., R. 10 E.; in native pasture):

A1—0 to 7½ inches, light brownish-gray (2.5Y 6/3) heavy loam, light olive brown (2.5Y 5/4) when moist; weak, fine, granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; weakly calcareous; pH 8.0; abundant roots; clear, wavy boundary.

C—7½ to 15 inches, pale-yellow (2.5Y 7/3) heavy loam, light olive brown (2.5Y 5/4) when moist; massive; weathered shale and soft sandstone in lower part of the horizon; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; lime nodules; pH 8.2; plentiful roots; gradual boundary.

R—15 to 27 inches +, thinly stratified soft sandstone, siltstone, and shale that are mainly pale yellow and olive yellow; strongly calcareous; lime nodules; few roots.

Only Bainville loam is mapped in the survey area, and it has a small acreage. The depth to weakly consolidated bedrock ranges from 1 to 2 feet.

BECKTON SERIES

The Beckton series consists of dark-colored Solonetz soils that have a moderately thick surface layer and have been solodized. These soils developed in clayey materials on terraces and high benches. The horizon sequence normally is (1) an A1 horizon and an A2 horizon that combined are 4 to 8 inches thick; (2) a moderately alkaline clay B2t horizon that has columnar and blocky structure; (3) a Ccasa horizon; and (4) a strongly calcareous light clay or heavy clay loam C horizon without lime segregations or salt accumulations.

The Beckton soils lack the shale substratum of the Rhoades soils. They have a thicker and darker colored A1 horizon than the Arvada soils and generally a thinner A2 horizon.

Typical profile of Beckton clay loam (300 feet east of the SW. corner of sec. 12, T. 16 N., R. 15 E.; between fence and private road, an area in native vegetation):

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; very weak, medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; plentiful roots; pH 8.0; clear boundary.

A12—3 to 5½ inches, dark grayish-brown (10YR 4/2) clay loam, very dark gray (2.5Y 3/2) when moist; weak, thin, platy structure; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; plentiful roots; pH 8.0; abrupt boundary.

A2—5½ to 7 inches, light brownish-gray (10YR 6/2) light clay loam, dark grayish brown (10YR 3.5/2) when moist; weak, medium, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; plentiful roots; pH 8.4; abrupt boundary.

B2t—7 to 13 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, columnar structure that breaks to moderate, medium and coarse, blocky structure in which blocks have fairly prominent, rounded caps; thick, continuous clay films on all ped faces; very hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; specks of salt crystals; plentiful roots but compressed; pH 8.2; clear boundary.

C1casa—13 to 28 inches, light olive-brown (2.5Y 5/3) light clay, olive brown (2.5Y 3/3) when moist; weak, medium and coarse, blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; thin, patchy clay films on vertical ped faces; strongly calcareous; threads of lime and salt crystals; few roots; pH 8.4; gradual boundary.

C2—28 to 38 inches, light olive-brown (2.5Y 5/3) silty clay in which fine gravel amounts to 5 percent of volume, grayish brown (2.5Y 4.5/2) when moist; massive; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; pH 8.4.

Beckton loam is the only Beckton soil mapped separately in the survey area, but Beckton clay loam occurs in complexes with Arvada, Danvers, and Savage soils. The Munsell notation of the A1 horizon of Beckton soils ranges from 2.5Y to 10YR in hue and from 1 to 2 in chroma. Value ranges from 4 to 5 for dry soil and from 2 to 3 for moist soil. The A2 horizon ranges from 2.5Y to 10YR in hue and from 1 to 2 in chroma. Value ranges from 5 to 7 for dry soil and from 3 to 5 for moist soil. In some profiles a Cca horizon occurs above the Ccasa, but generally it does not. The lime and salts normally occur together.

BIG TIMBER SERIES

The Big Timber series consists of well-drained, reddish Chestnut soils that have a thin solum and intergrade toward Lithosols. Big Timber soils occur on steep upland slopes of the foothills, where they developed in calcareous clay loam that weathered in place from shale interbedded with sandstone. The horizon sequence normally is (1) a thin A1 horizon; (2) a thin B2 horizon; (3) a C horizon; and (4) underlying weathered bedrock within 18 inches of the surface.

The Big Timber soils have a thinner A1 horizon than the Darret soils and, unlike them, have had little or no translocation of clay to the B2 horizon, are calcareous to the surface, and generally are shallower to shale. The color and the structural reddish B2 horizon of the Big Timber soils differentiate them from the yellower Midway soils that have no B horizons.

Typical profile of Big Timber clay loam (1,100 feet west and 350 feet north of the SE. corner of sec. 32, T. 18 N., R. 8 E.; on south slope in native range):

A1—0 to 2 inches, reddish-brown (2.5YR 5/4) clay loam, reddish brown (2.5YR 4/4) when moist; very weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; abrupt boundary.

B2—2 to 7 inches, reddish-brown (2.5YR 4/3) light clay that is 5 percent gravel and is dark reddish brown (2.5YR 3/3) when moist; moderate, very fine, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; clear boundary.

C—7 to 16 inches, weak-red (10R 5/2) light clay, dusky red (10R 3/2) when moist; a few fragments of sandstone and shale; weak, fine, angular and subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; few faint threads of lime in root holes; clear boundary.

CRca—16 to 29 inches, weak-red (10R 5/2) heavy clay loam, weak red (10R 4/2) when moist; a few fragments of shale and sandstone; weak, medium and fine, angular and subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; common, distinct lime splotches; clear boundary.

R—29 to 40 inches, reddish-colored clay loam shale having faint segregations of lime on underside of upper layers.

In the survey area Big Timber soils are mapped only in a complex with Cheadle soils and Rock outcrop. The A1 horizon ranges from 2 to 4 inches in thickness. In some places the horizons are light clay instead of clay loam. This different texture is a result of stratification of the parent material. Appreciable fragments of shale and sandstone occur within 18 inches of the surface, but in many places clay loam and clay that weathered from shale extend to a depth of 30 inches or more.

BLAINE SERIES

The Blaine series consists of well-drained Chestnut soils developed in loam and clay loam material that weathered from igneous rock on the uplands of the plains section. The identifying characteristics of Blaine soils are (1) a dark, thin A1 horizon and upper B2 horizon; (2) the distinctly higher clay content in the B2 horizon; (3) a Cca horizon; and (4) igneous rock, generally at a moderate depth.

The lighter color of the surface layer and the presence of a Cca horizon distinguish the Blaine soils from the nearly black, lime-free Woodhurst soils, which are Chernozems. The distinctly blocky B2 horizon distinguishes Blaine soils from the Spring Creek soils, which are shallow Lithosols.

Typical profile of Blaine stony loam (1,320 feet north and 1,300 feet east of the SW. corner of sec. 26, T. 19 N., R. 10 E.; in native range, approximately 400 feet west-southwest of point where bedrock is exposed):

A1—0 to 2 inches, dark-gray (10YR 4/1) fine gravelly heavy loam, black (10YR 2/1.3) when moist; moderate, medium and fine, granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.2; clear, wavy boundary.

B21t—2 to 8 inches, dark grayish-brown (10YR 4/2) fine gravelly light clay, dark brown (7.5YR 3/3) when moist; strong, very fine, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; thick, continuous clay films on all ped faces, films are very dark grayish brown (10YR 3.3/2) when dry and

very dark brown (10YR 2/2) when moist; noncalcareous; pH 7.8; gradual boundary.

B22t—8 to 16 inches, grayish-brown (10YR 5/2) fine gravelly clay between rocks that make up 80 percent or more of the horizon; soil material very dark grayish brown (10YR 3/2) when moist; strong, medium, angular blocky and weak, very fine, angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; thick clay films on medium blocks and in patches on rocks; calcareous; pH 7.8; clear, very irregular boundary.

C1ca—16 to 26 inches, mottled brown and very pale brown (10YR 5/3 and 7/3) fine gravelly clay loam, very dark grayish brown (10YR 3/2) when moist; rocks make up 80 percent or more of horizon; soil material has weak, very fine blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; patches of clay films on upper faces of stone in upper part of horizon; very strongly calcareous; concentration of flour lime in many threads and common splotches; soft lime coats pebbles and stones; pH 8.2; gradual boundary.

C2ca—26 to 35 inches, mottled grayish-brown and white (2.5Y 5/2 and 8/2) fine gravelly light clay loam mottled with dark grayish brown and light brownish gray (10YR 4/2 and 6/2) when moist; rocks make up 80 percent or more of horizon; soil material massive; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; concretions of flour lime in many threads and common white splotches; soft lime coats pebbles and stones; pH 8.6.

C—35 to 58 inches, gray (5Y 5/1) disintegrated monzinite porphyry rock to sand, dark olive gray (5Y 3/2) when moist; very strongly calcareous; pH 8.4.

R—58 inches +, unweathered monzinite porphyry bedrock.

In the survey area the surface layer of Blaine soils is loam and stony loam. These soils are mapped with the Spring Creek soils in complexes. The B2 horizon is generally 15 to 20 inches thick and ranges from clay loam to light clay. Rock fragments commonly make up 20 to 80 percent of the soil mass in the stony loam. Depth to bedrock ranges from 18 to 60 inches but is less than 24 inches in most places.

BLYTHE SERIES

The Blythe series consists of Planosols that have a thick surface layer and occur on uplands and fans in the foothills of the Highwood Mountains. The horizon sequence normally is (1) a very dark colored A1 horizon 5 to 10 inches thick; (2) a gray A2 horizon 5 to 8 inches thick; (3) a clay B2t horizon that has columnar structure in upper part and prismatic, blocky structure in lower part; (4) a B3ca horizon containing gypsum crystals; and (5) a Cca horizon.

The Blythe soils have a thicker, darker A1 horizon and a thicker A2 horizon than the Beckton soils, and unlike those soils, they lack salts other than gypsum. Blythe soils occur with the Alder soils on uplands and are distinguished from them by the presence of an A2 horizon and more clay in their B2 horizon.

Typical profile of Blythe loam (1,300 feet south of center of sec. 7, T. 18 N., R. 9 E.; in native pasture on north side of county road in right-of-way):

A1—0 to 6½ inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, fine, granular structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; pH 7.2; plentiful roots; clear boundary.

A2—6½ to 11 inches, gray (10YR 4/1) heavy loam, very dark gray (10YR 3/1) when moist; moderate, fine, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; pH 7.2; plentiful roots; abrupt boundary.

B21t—11 to 19 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) coated and 3/2 crushed) when moist; strong, medium, columnar structure; columns 2 inches long and rounded on top; they grade to moderate, coarse prisms that separate into moderate, medium, angular blocks; tongues of material from the A2 horizon between the columns; columns and blocks are extremely hard when dry, extremely firm when moist, and very sticky and very plastic when wet; distinct, thick, continuous clay films on ped faces; plentiful roots; pH 7.2; noncalcareous; clear boundary.

B22t—19 to 22 inches, dark-gray (10YR 4/1) light clay, very dark gray (10YR 3/1) when moist; moderate, medium prisms break to moderate, medium blocks; very hard when dry, very firm when moist, very sticky and very plastic when wet; distinct, continuous clay films on all ped faces; pH 8.0; weakly calcareous, small splotches of lime through the prisms; few roots between prisms; clear boundary.

B3ca—22 to 29 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium prisms break to moderate, medium blocks; peds coated white, limy crystals of gypsum; very hard when dry, very firm when moist, very sticky and plastic when wet; distinct, continuous clay films on ped faces; strongly calcareous; pH 8.2; few roots between prisms; clear boundary.

Cca—29 to 41 inches, dark grayish-brown (2.5Y 4/2) clay containing a few sandstone pebbles, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; distinct, continuous clay films on vertical faces of peds and patches on horizontal faces; strongly calcareous; pH 8.4; few roots.

Blythe loam is the only soil type mapped in this survey area. For a moist soil the Munsell notation for the A1 horizon is 10YR in hue, 2 or 3 in value, and 1 or 2 in chroma. The A1 and A2 horizons combined generally range from 10 to 18 inches in thickness, but in a few spots they are as little as 6 inches thick. Although lime segregations and calcareous material do not generally occur, there are calcareous horizons in some profiles that have bedrock at a depth of 30 inches or more. The depth to shale ranges from 24 to 36 inches on uplands and is generally more than 5 feet on fans.

BOWDOIN SERIES

The Bowdoin series consists of imperfectly drained Alluvial soils that developed in clayey materials and intergrade toward Grumusols. These soils are dominantly clay throughout and have fairly weak horizonation and a blocky subsoil. In this survey area, however, Bowdoin soils contain only 45 to 65 percent clay and have been mapped as a low clay variant. Their surface layer is thin silty clay or heavy silty clay loam.

The Bowdoin soils have a darker subsoil and a higher water table than the well-drained Promise soils.

Typical profile of Bowdoin silty clay, low clay variant (near center of NE¼NW¼ sec. 36, T. 15 N., R. 14 E.; in a pasture):

Ap—0 to 3 inches, dark-gray (10YR 4/1) heavy silty clay loam, very dark gray (10YR 3/1) when moist; moderate, fine, granular structure; friable when moist, sticky and plastic when wet; weakly calcareous; pH 8.0; abrupt boundary.

A1—3 to 10 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; strong, fine, blocky structure; firm when moist, sticky and very plastic when wet; weakly calcareous; pH 8.0; fine threads of salt; clear boundary.

C1g—10 to 20 inches, very dark gray (2.5Y 3/1, moist) clay; moderate, medium to coarse prisms separated into

moderate, fine blocks; firm when moist, very sticky and very plastic when wet; strongly calcareous; pH 8.0; clear boundary.

C2g—20 to 28 inches, black (2.5Y 2/1) clay distinctly mottled with dark gray (2.5Y 4/1) when moist; weak, medium to coarse prisms separated into moderate, fine blocks; firm when moist, sticky and very plastic when wet; strongly calcareous; many lime splotches; pH 8.0; gradual boundary.

C3g—28 to 32 inches, very dark gray (2.5Y 3/1) clay mottled with dark gray (2.5Y 4/1) when moist; moderate, coarse, prismatic structure; very firm when moist, very sticky and very plastic when wet; strongly calcareous; gradual boundary.

C4g—32 to 44 inches, gray (2.5Y 5/1) clay mottled with yellowish brown (2.5Y 5/4) when moist; massive; very firm when moist, very sticky and very plastic when wet; strongly calcareous.

C5g—44 inches +, same as horizon above but more dense.

The surface layer ranges from silty clay to silty clay loam, but silty clay is the only type mapped in the survey area. The water table is generally 2½ to 5 feet below the surface.

BRIDGER SERIES

The Bridger series consists of well-drained Chernozems developed in loamy alluvium that was derived from igneous rock, shale, and sandstone on fans and foot slopes in the foothills. The horizon sequence of Bridger soils normally is (1) a thick, black A1 horizon that has granular to crumb structure; (2) a strong, prismatic-blocky B2t horizon; (3) a weak to distinct Cca horizon containing segregated lime; and (4) a C horizon in which pebbles, cobblestones, and stones make up 10 to 30 percent of horizon.

The Bridger soils are distinguished from the Adel soils by a thinner A1 horizon, more clay in the B2 horizon, and more accumulated lime and generally a higher percentage of coarse fragments in the C horizon.

Typical profile of Bridger loam (about 1,150 feet west and 950 feet south of NE. corner of SE¼ sec. 21, T. 15 N., R. 10 E.; in hayfield approximately 125 feet north of fence running northeast-southwest, and 215 feet southwest of barn):

A1p—0 to 4½ inches, very dark gray (10YR 3/1) loam that contains a few pebbles, black (10YR 2/1) when moist; weak, fine, crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; pH 7.2; gradual boundary.

A12—4½ to 7 inches, very dark gray (10YR 3/1) loam that contains a few pebbles, black (10YR 2/1) when moist; weak, medium and fine, blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; few, thin patches of clay films where loam touches pebbles; pH 7.4; gradual boundary.

B21t—7 to 12 inches, brown (10YR 5/3) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, blocky structure; hard when dry, friable when moist; very sticky and plastic when wet; moderately thick, continuous clay films on all faces of peds; pH 7.6; clear boundary.

B22t—12 to 18 inches, brown (10YR 5/3) heavy clay loam, dark grayish brown (10YR 4/2) when moist; strong, medium, angular blocky structure; hard when dry, friable when moist, very sticky and plastic when wet; very thick, continuous clay films on all faces of peds; pH 7.6; gradual boundary.

B3—18 to 28 inches, brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, blocky structure; hard when dry, friable when moist, very sticky and plastic when wet; thin, nearly continuous clay films on ped faces; pH 8.2; clear boundary.

C1ca—28 to 33 inches, light grayish-brown (2.5Y 6/2) light clay loam, olive gray (2.5Y 4/2) when moist; massive to weak, medium, platy structure; slightly hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; many small threads of lime; lime coats on pebbles; pH 8.4; clear boundary.

IIC2ca—33 to 42 inches, light-gray (10YR 7/2) gravelly clay loam, light brownish gray and grayish brown (10YR 6/2 and 5/2) when moist; massive; friable when moist, sticky and plastic when wet; strongly calcareous; lime coats on pebbles.

Loam and stony loam types are mapped in this survey area. When dry the A1 horizon has a hue of 10YR, a value of 2 to 4, and a chroma of less than 1.5. The B2 horizon ranges from clay loam to light clay. Depth to the Cca horizon ranges from 20 to 30 inches.

CASTLE SERIES

The Castle series consists of very dark colored, calcareous Grumusols that developed in clay weathered in place from clay shale on rolling uplands in the foothills. Characteristics of Castle soils are (1) a profile of calcareous clay; (2) a very dark colored, granular A1 horizon; (3) a subsoil 1 or 2 less in chroma than the A1 horizon; and (4) widely spaced contracting cracks that extend deep in the profile.

The very dark-colored A1 horizon of the Castle soils distinguishes them from the Pierre and Promise soils.

Typical profile of Castle clay (600 feet north and 500 feet east of the center of sec. 26, T. 16 N., R. 10 E.; in native range):

A1—0 to 9 inches, very dark grayish-brown (10YR 3/2) clay, very dark grayish brown (10YR 2.6/2) when moist; moderate, fine, granular structure in upper part, and weak, blocky structure in lower part; hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.0; abundant roots; clear boundary.

C1—9 to 19 inches, neutral (N 3.4/0 dry and moist) dense clay; strong, medium and coarse, prismatic structure; prominent pressure faces on prisms, and shale fragments within prisms; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; plentiful roots extend downward along prism faces; strongly calcareous; few lime splotches varying from ¼ to ½ inch in size; pH 8.0; clear boundary.

C2—19 to 31 inches, neutral (N 3.4/0 dry or moist) dense clay with few, fine, distinct, colored mottles; strong, prominent pressure faces that break apart like balls and sockets; few roots flattened against the pressure faces; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; strongly calcareous; pH 8.2; gradual boundary.

C3—31 to 35 inches +, when dry or moist, neutral (N 3.4/0) and brown mottled (10YR 5/3) clay shale; massive; high percentage of aragonite particles; extremely hard when dry, extremely firm when moist, nonsticky and nonplastic when wet; strongly calcareous; threads of lime; pH 8.4.

Castle clays and a complex of Castle soils are mapped in the survey area. The A1 horizon ranges from 3 to 10 inches in thickness. Few to common films and splotches of lime occur below the A1 horizon. In places the C1 horizon contains a layer of crystalline, calcium carbonate (aragonite) 1 or 2 inches thick. Depth to bedded shale ranges from 20 to 40 inches.

CHAMA SERIES

The Chama series consists of weakly developed, moderately dark colored Chestnut soils that have a thin solum and developed from slightly consolidated clay loam shale

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in the uplands of the plains. In this survey area the normal sequence of horizons is (1) a thin, dark A1 horizon; (2) a thin, transitional B2 or AC horizon; and (3) a Cca horizon that merges with bedrock.

The Chama soils have a thinner solum than the Straw soils and stronger accumulation of lime. Unlike the Straw soils, Chama soils have a shale substratum. They are darker colored and deeper than the Bainville soils and have a stronger accumulation of lime.

Typical profile of Chama clay loam (on east side of highway, 165 feet east and 75 feet north of SW. corner of sec. 20, T. 11 N., R. 16 E.; inside of right-of-way):

A11—0 to 2 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (2.5Y 2.3/2) when moist; moderate, thin, platy structure; soft when dry, friable when moist, sticky and plastic when wet; pH 8.2; abrupt boundary.

A12—2 to 5 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2.3/2) when moist; weak, coarse, prismatic structure to moderate, fine and medium, granular structure; soft when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 8.2; clear boundary.

B2—5 to 8 inches, dark grayish-brown (10YR 4/2.3) clay loam, dark brown (10YR 3/3.3) when moist; weak, medium, prismatic structure to weak, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; abundant roots; noncalcareous; pH 8.2; gradual boundary.

C1ca—8 to 17 inches, pale-brown (10YR 6/3) clay loam, light olive brown (10YR 5/3) when moist; moderate, very coarse, prismatic structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; lime disseminated and segregated in many fine, white threads and small soft masses; pH 8.4; clear boundary.

C2ca—17 to 36 inches, light-gray (5Y 7/2) clay loam, olive (5Y 5/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; roots plentiful; strongly calcareous; lime disseminated and segregated in many white threads and small soft masses; pH 8.4; gradual boundary.

C3—36 to 48 inches, light-gray (5Y 7/2) weathered clay loam shale, light gray (5Y 6/1) when moist; shale coated with pale olive (5Y 6/4) and brown (7.5 YR 5/2) when dry or moist; weak, thick, platy structure; hard when dry, firm when moist; few roots; strongly calcareous; pH 8.8; gradual boundary.

R—48 to 56 inches, light-gray (5Y 6/1) clay loam shale, gray (5Y 5/1) when moist; very hard when dry, firm when moist; fragments of shale plates coated with olive and brown; strongly calcareous; pH 8.8.

Chama clay loam is the only Chama soil in this survey area. Its A1 horizon ranges from 3 to 5 inches in thickness. In most places a thin B2 horizon is between the A1 and Cca horizons, but in some places this thin horizon is an AC horizon. Under cultivation the surface normally becomes calcareous. Depth to shale generally ranges from 2 to 4 feet.

CHEADLE SERIES

The Cheadle series consists of dark-colored Lithosols that developed over hard sandstone on the uplands. The normal horizon sequence is (1) a dark-colored A1 horizon; (2) a transitional AC or C horizon that is generally calcareous; and (3) sandstone near the surface.

The sandstone underlying the Cheadle soils distinguishes them from the Duncom soils, which are underlain by limestone, and from the Spring Creek soils, which are underlain by igneous rock. The Cheadle soils lack the thick, black subsoil of the Teton soils.

Typical profile of Cheadle stony loam (600 feet north and 300 feet west of NE. corner of SE¼ sec. 26, T. 16 N., R. 9 E.; in a native pasture):

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) stony loam, very dark brown (10YR 2/2) when moist; single grain and weak, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; roots abundant; noncalcareous; pH 7.8; clear boundary.

AC—4 to 12 inches, dark grayish-brown (10YR 4/2) stony loam that has a stone content of 50 percent, by volume; very dark grayish brown (10YR 3/2) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; roots somewhat matted on upper side of sandstone layers; weakly calcareous; underside of sandstone coated with lime; pH 8.6; abrupt boundary.

R—12 inches +, fractured sandstone with stalactites and lime coating on underside; roots follow fractures and are somewhat matted on upper side of sandstone layers.

Loam, stony loam, and channery loam types occur in the survey area. Stony loam and channery loam commonly are mapped in complexes with the Darret, Teton, and Absarokee soils. For dry soil the Munsell notation of the A1 horizon is 10YR in hue, 4 or 3 in value, and 1 or 2 in chroma. In most places the stony loam and channery loam ranges from 8 to 18 inches in depth to bedrock, but the loam ranges from 15 to 24 inches. Some lime generally accumulates on the underside of sandstone fragments above the bedrock, and on the underside of sandstone layers in the upper part of the bedrock.

COLVIN SERIES

The Colvin series consists of poorly drained Solonchak soils that are rich in calcium carbonate and developed in clay loam alluvium in valleys and on terraces in the plains section. The Colvin soils are characterized by a dark A1 horizon and a light-colored, gleyed subsoil that has distinct accumulations of lime carbonate.

The distinct accumulations of lime carbonate in the subsoil distinguish the Colvin soils from the closely associated Lamoure soils. Lamoure soils have a strongly calcareous subsoil, but they lack distinct accumulations of lime carbonate.

Typical profile of Colvin clay loam (1,200 feet east and 550 feet south of NW. corner of SW¼ sec. 12, T. 14 N., R. 15 E., 345 feet southward from wire gate on U.S. Highway No. 87; in native pasture):

O2—½ inch to 0, muck; strongly calcareous; roots abundant; abrupt boundary.

A1g—0 to 13 inches, gray (N 5/0) clay loam, very dark gray (N 3/0) when moist; weak, fine and medium, granular structure in upper few inches and moderate, thin platy structure that separates to moderate, fine, granular structure below; slightly hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; abrupt boundary.

C1cag—13 to 21 inches, light-gray (N 7/0) clay loam with common, medium, faint mottles of gray (N 5/0) when dry; light gray (N 6/0) with common, medium, faint mottles of dark gray (N 4/0) when moist; massive to weak, fine, granular structure; hard when dry, friable when moist, slightly sticky and plastic when wet; very strongly calcareous; estimated 30 percent calcium carbonate equivalent; distribution of calcium carbonate indicated by the mottling; clear boundary.

C2cag—21 to 35 inches, light grayish-brown (2.5Y 6/2) clay loam with common, medium, faint mottles of light olive brown (2.5Y 5/4) when dry; light olive brown (2.5Y

5/4) with common, medium, faint mottles of olive brown (2.5Y 4/4) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; few large specks of calcium carbonate; gradual boundary.

C3—35 to 50 inches, light brownish-gray (2.5Y 6/2) sandy clay loam with common, medium, faint mottles of light olive brown (2.5Y 5/2) when dry; grayish brown (2.5Y 5/2) when moist; massive; very hard when dry, very friable when moist, sticky and plastic when wet; weakly calcareous; few specks of calcium carbonate; abrupt boundary.

IIC4—50 inches +, very gravelly sandy clay loam.

In the survey area Colvin soils are mapped only in a complex with Lamoure soils. The A1 horizon ranges from 6 to 15 inches in thickness. The water table generally occurs at a depth of 3 to 5 feet. The depth to the gravelly material ranges from 2 to 5 feet. The high water table is caused by the impervious shale that underlies these soils at a depth of 6 feet or more. The subsoil ordinarily is mottled with shades of gray, brown, and yellow.

COWOOD SERIES

Soils of the Cowood series are light-colored gravelly or stony loam or silt loam that developed in residuum from igneous rock. They are Gray Wooded soils that intergrade toward Lithosols. Cowood soils are characterized by (1) a thin to moderately thick layer of forest litter and humus; (2) clean, bleached grains of silt and sand in the A2 horizon; (3) a B2 horizon containing stained and coated sand grains, some clay-coated peds, and rock fragments filmed with patches of clay; and (4) igneous bedrock not deep in the profile.

The Cowood soils lack the Cca horizon and the dark-colored A1 horizon of the Spring Creek soils, which occur in grassland. They also lack the clayey B2t horizon of the Loberg soils.

Typical profile of Cowood stony loam (600 feet SE. of center of sec. 15, T. 19 N., R. 9 E.; in native woodland):

O1—2 inches to 0, forest litter of decomposed leaves and branches; bound by roots.

A2—0 to 6 inches, light brownish-gray (10YR 6/2) gravelly silt loam, dark brown (10YR 3/3) when moist; stones scattered on surface; weak, fine, crumb structure; crumbs arranged in weak, thin plates in upper inches; soft when dry, very friable when moist, nonsticky and nonplastic when wet; silt and very fine sand is clear and unstained; pH 5.2; abundant roots; clear, irregular boundary.

B2—6 to 12 inches, grayish-brown (10YR 5/2) very gravelly silt loam, very dark grayish brown (10YR 3/2) when moist; massive; soft when dry, very friable when moist; stained silt and very fine sand; patches of clay films on pebbles; pH 5.5; few roots; clear boundary.

CR—12 to 23 inches, light brownish-gray (10YR 6/2) silt in crevices of the weathered basalt that readily crumbles to fragments of gravel; silt is dark grayish brown (10YR 4/2) when moist; patches of thick clay films on some pebbles; pH 5.5.

R—23 to 26 inches, olive-gray (5Y 4/2) slightly weathered basalt that is black (5Y 2/2) when moist and can be cut with a spade; patches of clay films on some faces of rock fragments.

Only Cowood stony loam is mapped in the survey area, but loam, silt loam, and gravelly silt loam occur in small areas. The bedrock ranges from soft and crumbly near the surface to hard deeper in the profile. Clean or bleached grains of sand and silt are prominent in the A2 horizon, but the B2 horizon is identified by stained grains of sand and silt in some profiles, or by clay films on peds and rock fragments in others.

DANVERS SERIES

The Danvers series consists of well-drained Chestnut soils on high benches and terraces in the plains. These soils developed in clay loam underlain by pebbles mixed with material finer than sand. The loamy, calcareous parent material is assumed to be alluvium and windblown material that overlie thick, very gravelly or very cobbly deposits of Pleistocene and Pliocene ages. The rounded pebbles and cobblestones are mainly limestone, quartzite, and granite. The normal horizon sequence of soils in the Danvers series is (1) a dark A1 horizon 3 to 5 inches thick; (2) a prismatic-blocky heavy clay loam B2 horizon 5 to 12 inches thick; (3) a weakly calcareous B3 horizon; (4) a prominent Cca horizon; and (5) very gravelly calcareous material.

Typical profile of Danvers clay loam (190 feet south and 125 feet west of the NE. corner of sec. 1, T. 18 N., R. 12 E.; in a summer-fallowed strip on a slope of less than 1 percent):

Ap—0 to 4 inches, gray (10YR 5/1) clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry; firm when moist, sticky and plastic when wet; abrupt boundary.

B2t—4 to 10 inches, grayish-brown (2.5Y 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; compound structure in which moderate, medium prisms separate to medium and fine, subangular blocks; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all ped faces; plentiful roots; clear boundary.

B3—10 to 14 inches, gray (10YR 5/1) clay loam that has a moderate amount of fine gravel and is dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on vertical faces and patches of clay films on horizontal faces; slight effervescence; plentiful roots; gradual boundary.

C1ca—14 to 23 inches, gray (10YR 6/1) light clay, grayish brown (10R 5/2) when moist; moderate, medium and fine, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; patches of clay films on vertical faces; violent effervescence; few roots; gradual boundary.

C2ca—23 to 34 inches, light-gray (5Y 7/2) light clay, olive gray (5Y 5/2) when moist; massive; slightly hard when dry, friable when moist, very sticky and plastic when wet; violent effervescence; few roots; clear boundary.

IIC3ca—34 to 39 inches, light-gray (5Y 7/2) gravelly sandy clay loam, olive gray (5Y 7/2) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; violent effervescence; few roots; clear boundary.

IIC4—39 to 50 inches, light-gray (5Y 7/2) very gravelly sandy loam, olive gray (5Y 5/2) when moist; massive; loose when dry, very friable when moist, nonsticky and nonplastic when wet; violent effervescence.

Danvers clay loam is the dominant soil type in the survey area, but gravelly clay loam, cobbly clay loam, and stony clay loam also occur. The Munsell notation of the A1 horizon is 10YR or 2.5Y in hue and 2 or 3 in chroma. Value is 4 or 5 dry and 2 or 3 wet. The B2 horizon has 2 to 8 percent more clay than the A1 horizon. Lime is in the form of nodules, lime flour distributed through the soil, and coats on the underside of pebbles and on soil in the gravel sockets. Depth to the very gravelly substratum

ranges from about 24 to 50 inches. The fine material that is mixed with the pebbles ranges from sandy loam to clay loam.

DARRET SERIES

In the Darret series are well-drained Chestnut soils that developed on the uplands in the foothills. These soils consist of reddish clay loam that weathered in place from clay loam shale interbedded with sandstone. The normal horizon sequence is (1) a granular A1 horizon about 4 inches thick; (2) a noncalcareous B2 horizon of heavy clay loam or light clay that has prismatic-blocky structure and continuous clay films on the ped faces; and (3) a weakly calcareous or noncalcareous C horizon that merges with the bedrock at a moderate depth.

Typical profile of Darret clay loam (1,325 feet east and 500 feet north of SW. corner of NW¼, sec. 28, T. 18 N., R. 8 E.; 20 feet east of center of road; in native range):

A1—0 to 4 inches, dark reddish-gray (5YR 4/2) clay loam, dark reddish brown (5YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; pH 7.6; noncalcareous; abundant roots; clear boundary.

B21t—4 to 8 inches, dark reddish-gray (5YR 4/2) silty clay loam, dark reddish brown (5YR 3/2) when moist; weak, prismatic structure that breaks to moderate, medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; distinct, continuous clay films on all ped faces; noncalcareous; pH 7.4; abundant roots; clear boundary.

B22t—8 to 13 inches, weak-red (2.5YR 4/2) silty clay, dusky red (2.5YR 3/2) when moist; moderate, medium and coarse, prismatic structure that breaks to moderate, medium and fine, blocky structure; hard when dry, friable when moist, very sticky and very plastic when wet; distinct, continuous clay films on all ped faces; noncalcareous; pH 7.8; abundant roots; clear boundary.

C—13 to 19 inches, weak-red (2.5YR 4/2) clay loam and fragments of shale and soft sandstone that amount to 25 percent of horizon; dusky red (2.5YR 3/2) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; weakly calcareous; pH 8.0; abundant roots; clear boundary.

CR—19 to 28 inches, weak-red (2.5YR 4/2) clay loam and weathered shale and soft sandstone that amount to 40 to 50 percent of horizon, dusky red (2.5Y 3/2) when moist; massive; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; pH 8.2; thin lime coats underside of shale and sandstone fragments; contains pockets of shale fragments that are coated with lime on all sides; few roots; clear boundary.

R—28 to 36 inches, reddish, weathered, soft sandstone and shale; pH 8.4; few roots compressed into mat between the shale and sandstone layers.

Clay loam is the dominant type in the survey area, but loam and stony clay loam occur in small areas. Depth to relatively unaltered bedrock ranges from 18 to 36 inches but is dominantly 20 to 30 inches. The profile is noncalcareous in some places where it is thinner than normal, but generally the C horizon is calcareous, and lime thinly coats the underside of the upper layers of the bedrock. In the thicker profile a Cca horizon may occur.

DIMMICK SERIES

The Dimmick series consists of Humic Gley soils that are poorly drained, noncalcareous clay. These soils developed in depressions and the basins of small intermittent lakes.

The Dimmick soils are similar to the Fargo soils but are deeper to lime.

Typical profile of Dimmick clay (200 feet south and 200 feet west of NE. corner of SE¼ sec. 25 T. 18 N., R. 10 E.; in native pasture):

A1—0 to 2 inches, grayish-brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, crumb structure; friable when moist, sticky and plastic when wet; noncalcareous.

C1g—2 to 5 inches, gray (N 5/1) silty clay, very dark gray (N 3/1) mottled with dark reddish brown (2.5YR 3/3) when moist; weak to moderate, fine, blocky structure; friable when moist, sticky and plastic when wet; noncalcareous.

C2g—5 to 15 inches, gray (N 5/1) clay, very dark gray (N 3/1) stained with few vertical streaks of gray (N 5/1) when moist; firm when moist, sticky and plastic when wet; noncalcareous.

C3g—15 to 30 inches, massive dense clay that has same color as horizon above; very firm when moist, very sticky and very plastic when wet; noncalcareous.

Dimmick clay is the only type mapped in the survey area, but there are small areas of heavy clay loam. The surface horizon ranges from 2 to 5 inches in thickness and is the only part of the profile that is not gleyed.

DUNCOM SERIES

The Duncom series consists of dark-colored Lithosols that developed on hard limestone and limy shale in the uplands of the foothills and mountainous areas. The normal horizon sequence is (1) a dark-colored A1 horizon; (2) a strongly calcareous, thin C horizon; and (3) bedrock near the surface.

The limestone underlying the Duncom soils distinguishes them from the Cheadle and Spring Creek soils. The Cheadle soils are underlain by sandstone, and the Spring Creek soils are underlain by igneous rock.

Typical profile of Duncom stony loam (1,250 feet east and 150 feet north of the center of sec. 22, T. 15 N., R. 10 E.; in native range):

A1—0 to 5 inches, very dark brown (10YR 2/2) stony loam, black (10YR 2/1) when moist; very weak, medium and fine, blocky structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; weakly calcareous; lime coats underside of stones and cobblestones; clear boundary.

C—5 to 12 inches, grayish-brown (10YR 5/2) loam that contains pebbles and cobblestones amounting to 20 percent of horizon, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; most pebbles and cobblestones entirely coated with lime; abrupt boundary.

R—12 inches +, dark-colored, massive, weakly fractured slab of hard limestone; lime carbonate coats surface of slab and has accumulated in the fractures.

The Duncom soils occur closely with the Skaggs, the Hughesville, and the Cheadle soils. The soil types in the survey area are stony loam and stony clay loam. The A horizon ranges from 3 to 5 inches in thickness, and the depth to bedrock generally is 8 to 15 inches.

FARGO SERIES

The Fargo series consists of poorly drained Grumusols that occur on valley bottoms and on low terraces. These soils are generally calcareous throughout. They are identified by their thick, black A1 horizon and their underlying neutral to olive-colored gleyed horizons.

In some areas of Fargo soils lime has accumulated in small specks and splotches below a depth of 16 inches, but the accumulations are not strong, as they are in the associated Hegne soils. Fargo soils are finer textured than the Lamoure soils.

Typical profile of Fargo silty clay (50 feet west of NE. corner of SW¼ sec. 18, T. 17 N., R. 12 E.; in native meadow):

O2—1½ inches to 0, muck and abundant roots; strongly calcareous; pH 8.6; abrupt boundary.

A11—0 to 4 inches, black (10YR 2/1, moist) silty clay, dark gray (N 4/0) when dry; moderate, fine, granular structure; very hard when dry, friable when moist, very sticky and very plastic when wet; abundant roots; strongly calcareous; pH 8.6; gradual boundary.

A12g—4 to 17 inches, very dark gray (N 3/0, moist) light clay, dark gray (N 4/0) when dry; moderate, medium and fine, granular structure; very hard when dry, friable when moist, very sticky and very plastic when wet; plentiful roots; strongly calcareous; pH 8.6; clear boundary.

C1g—17 to 61 inches, in upper part mottled dark gray and very dark gray (N 4/0 and 3/0, moist) clay and a few small pebbles coated with lime, gray and dark gray (N 5/0 and 4/0) when dry; below 36 inches, dark gray (N 4/0, moist) with common, medium, prominent mottles of yellowish red (5YR 4/6); very weak, fine, angular blocky structure to massive; extremely hard when dry, extremely sticky and very plastic when wet; few roots; weakly calcareous; small splotches and concretions of lime; pH 8.6; gradual boundary.

C2g—61 to 63 inches, gray (N 5/0, moist) clay with common, medium, prominent mottles of yellowish red (5YR 4/6), light gray (N 6/0) when dry; gravel makes up 10 percent of horizon; extremely firm when moist, very sticky and very plastic when wet; few roots; weakly calcareous; pH 8.4.

IIC3—63 inches +, very gravelly clay.

The Fargo soils occur closely with the Hegne soils in the survey area and are mapped with them in a complex. Generally, the Fargo soils have an O2 horizon. When the soil is moist, the Munsell notation of the A1 horizon ranges from 10YR 2/1 to N 2/0. Neutral colors are dominant in the subsoil, but in some places the subsoil has a chroma of 3 or less if the hue is 5Y and 2 or less if it is 2.5Y. Value ranges from 3 to 5. The subsoil is commonly mottled with yellow and brown. In many places the structure of the subsoil is angular blocky. The water table rises to within a few inches of the surface at times, but generally it is 2 to 5 feet below the surface.

FERGUS SERIES

The Fergus series consists of well-drained Chestnut soils that developed in reddish-colored clay loam alluvium on fans and stream terraces in the foothills of the survey area. The normal horizon sequence is (1) an A1 or Ap horizon about 4 inches thick; (2) a transitional AB or B1 horizon 4 or 5 inches thick; (3) a prismatic-blocky B2t horizon that has distinct, continuous clay films on ped faces; and (4) IIIB3ca or Cca horizon that grades to a IIIC horizon consisting of calcareous material.

The reddish color of the Fergus soils distinguishes them from the Savage soils. In Fergus soils a noticeable amount of clay has moved from the A1 horizon to form a B2 horizon that is more clayey and stronger in structure than the B2 horizon of Twin Creek soils. Also, Fergus soils have a stronger accumulation of lime in the lower subsoil than Twin Creek soils.

Typical profile of Fergus clay loam (300 feet west and 900 feet north of the SW. corner of SE¼ sec. 4, T. 17 N., R. 9 E.; west of farmstead road in hayfield):

Ap—0 to 4 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure, slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 7.2; abundant roots; abrupt boundary.

AB—4 to 9 inches, dark-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; thick, distinct clay films on all faces of peds; noncalcareous; pH 7.2; abundant roots; clear boundary.

B21t—9 to 28 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium and coarse, prismatic structure that breaks to moderate, medium and coarse, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; very thick, distinct, continuous clay films on all faces of peds; noncalcareous; pH 7.6; plentiful roots; clear boundary.

IIB22t—28 to 34 inches, reddish-brown (5YR 4/3) gravelly clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, blocky structure; hard when dry; friable when moist, sticky and plastic when wet; thick, continuous clay films on all ped faces; weakly calcareous; few, faint threads of lime; pH 8.0; few roots; abrupt boundary.

IIIB3ca—34 to 40 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium and coarse, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; continuous clay films on all faces of peds, broken only by splotches and threads; pH 8.4; few roots; clear boundary.

IIIC—40 to 47 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; pH 8.6.

Fergus clay loam and Fergus silty clay loam are the only types mapped in the survey area. In a dry soil the A1 horizon has a hue ranging from 10YR to 5YR, value of 5 to 3, and chroma of 2. The B horizon in a dry soil is 7.5YR or redder in hue, 2 or more in chroma, and 5 or 4 in value. The B horizon ranges from clay loam to light clay. Lime is segregated in the IIIB3ca horizon as films and seams, and as small and large, rounded, slightly hard concretions of pure calcium carbonate.

GALLATIN SERIES

The Gallatin series consists of deep, imperfectly drained soils that developed in loam and clay loam alluvium that was recently deposited on the flood plains along streams. These soils are Chernozems that intergrade toward Alluvial soils. Their profile is identified by its thick, dark colored A1 horizon and its lighter colored C horizon that is mottled with brown and reddish colors.

The Gallatin soils are calcareous, whereas the Slocum soils are noncalcareous. The Gallatin soils are better drained than the Lamoure soils and less gleyed in the subsoil.

Typical profile of Gallatin loam (600 feet south of center of sec. 24, T. 16 N., R. 11 E.; on east side of Wolf Creek in native hay):

A11—0 to 2 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate, medium, crumb structure; many worm casts; soft when dry, friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 7.8; abundant roots; clear boundary.

A12—2 to 13 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) mottled with dark yellowish brown (10YR 4/4) when moist; mottles are common, fine, and distinct; strong, coarse, granular and crumb structure; many worm casts; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.0; plentiful roots; gradual boundary.

A13—13 to 25 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) mottled with very dark grayish brown (10YR 3/2) when moist; mottles are few, medium, and faint; strong, coarse, granular and crumb structure; many worm casts; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; weakly calcareous; pH 8.2; few roots; gradual boundary.

C1—25 to 45 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) mottled with dark yellowish brown (10YR 3/4) when moist; mottles are common, medium, and faint; massive; many earthworm casts; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; pH 8.4; gradual boundary.

C2—45 to 62 inches, dark-gray (10YR 4/1) stratified loam and sandy loam, prominently mottled with dark brown (7.5YR 4/4) when moist; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.4.

IIC3—62 inches +, gravel.

Mapped in the survey area are loam, clay loam, and loam, clay substratum. The upper part of the A1 horizon is noncalcareous in some places, but generally the profile is calcareous throughout. Between a depth of 10 and 30 inches, texture ranges from heavy fine sandy loam through loam to clay loam. Below a depth of 30 inches, the soil material ranges from sand to clay, but normally the 5-foot profile is stratified loam or clay loam. In a dry soil the Munsell notation of the A1 horizon is redder than 5Y or yellower than 5YR in hue, 4 or 3 in value, and 1 or 2 in chroma. The C horizon has a chroma of 1 or 2 and hue that is redder than 5Y or yellower than 5YR. The C horizon contains specks or threads of segregated lime in some places.

HEGNE SERIES

The Hegne series consists of poorly drained Solonchak soils that are rich in calcium carbonate and developed in calcareous clay in valley bottoms or on low terraces. The profile is identified by its black A1 horizon that generally is less than 10 inches thick and grades to a prominent, neutral or olive-gray Cca horizon.

The Hegne soils are distinguished from the Fargo soils by a thinner A1 horizon and a prominent Cca horizon within 16 inches of the surface. They are finer textured throughout the profile than the Colvin soils.

Typical profile of Hegne silty clay (1,400 feet east and 750 feet north of SW. corner of sec. 29, T. 18 N., R. 13 E.; 305 feet west of fence corner):

O2—2 inches to 0, organic material.

A11—0 to 2 inches, very dark gray (10YR 3/1) light clay, black (10YR 2/1) when moist; weak, very fine, granular structure; slightly hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; clear boundary.

A12g—2 to 6 inches, dark-gray (N 4/0) silty clay, black (N 2/0) when moist; weak, medium and coarse prisms that separate to moderate, very fine blocks; hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; clear boundary.

C1cag—6 to 17 inches, gray (N 5/0) clay, very dark gray (N 3/0) when moist; moderate, very fine, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; common, medium masses of lime carbonate; strongly calcareous; clear boundary.

C2cag—17 to 36 inches, gray (N 5/0) clay, gray (5Y 5/1) when moist; weak, medium, prismatic structure that breaks to moderate, fine, subangular and angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; common, medium, distinct masses of lime carbonate; few, fine, faint mottles of iron; clear boundary.

C3cag—36 to 58 inches, light-gray (N 7/0) clay, gray (N 6/0) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; common, fine and medium, distinct masses of lime carbonate; distinct, prominent mottles of iron; clear boundary.

IIC4—58 to 63 inches, gray (N 6/0) gravelly sandy loam, gray (N 5/0) when moist; weakly calcareous; distinct mottles of iron.

Hegne silty clay is the only type recognized in the survey area, and it is mapped in a complex with the Fargo soils. In some places a layer of light clay 2 inches thick is at the surface. The A1 horizon ranges from 6 to 10 inches in thickness and is generally calcareous at the surface. The lime segregations immediately below the dark surface layer are faint or prominent, but the lime is rather strongly disseminated at this depth. Within 20 inches of the surface, the lime carbonate is distinctly to prominently segregated. The subsoil is mottled with iron.

HUGHESVILLE SERIES

Soils of the Hughesville series developed in loamy material that weathered in place or in local material transported from hard limestone and limy shale. They are Gray Wooded soils that have a thin solum. The mineral profile of Hughesville soils is under a thin layer of forest litter and humus and is identified by (1) its gray A2 horizon ½ inch to 2 inches thick; (2) its thin, dark-colored B2 horizon; (3) its light-colored, strongly calcareous C horizon; and (4) bedrock at a moderate depth.

Typical profile of Hughesville stony loam (approximately 800 feet north and 1,000 feet east of the center of sec. 3, T. 16 N., R. 8 E.; in woodland made up of native trees):

O1—1 to ¼ inch, pine needles.

O2—¼ inch to 0, humus.

A2—0 to 1 inch, gray (10YR 5/1) loam, very dark brown (10 YR 2/2) when moist; moderate, fine, crumb structure; soft when dry, friable when moist; nonsticky and nonplastic when wet; noncalcareous; pH 7.4; abundant roots; abrupt, irregular boundary.

B1—1 inch to 1¼ inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) when moist; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; thin, patchy clay films on vertical faces of peds; noncalcareous; pH 8.4; abundant roots; clear, wavy boundary.

B2t—1¼ to 5½ inches, brown (10YR 4/3) stony light clay loam, very dark brown (10YR 2/2) when moist; weak, medium, blocky structure that breaks to moderate, fine, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; thin, patchy clay films on ped faces; noncalcareous; pH 8.4; abundant roots; clear, wavy boundary.

B3—5½ to 12 inches, dark grayish-brown (10YR 4/2) gravelly clay loam, brown (10YR 4/3) when moist; weak, fine, blocky structure that breaks to moderate, fine, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous in spots; pH 8.6; thick patches of clay films on

ped faces; abundant roots; gradual, irregular boundary.

C—12 to 27 inches, grayish-brown (2.5Y 5/2) sandy clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist, sticky and plastic when wet; strongly calcareous; pH 8.8; abundant roots; developed in shattered limestone; clear boundary.

R—27 inches +, slightly fractured hard limestone.

Clay loam and stony clay loam are the principal soil types in the survey area, but loam and stony loam also occur. The different types, however, are not mapped separately. A thin B1 horizon occurs in some places. The B2t horizon has a high percentage of silt and clay amounting to 25 to 35 percent of the horizon. The hue of these soils generally is 10YR in the survey area. Chroma of the B horizon ranges from 2 to 4. Value in a dry soil ranges from 3 to 5 and is generally lowest in the upper part of the B horizon. The lower part of the B horizon is generally calcareous, and the parent material and parent rock are strongly calcareous. Depth to bedrock normally ranges from 18 to 30 inches, but it is as much as 4 feet in some local areas where the soil developed partly in alluvium.

JUDITH SERIES

The Judith series consists of dark-colored Calcisols that developed in very strongly calcareous, loamy alluvium. This alluvium is underlain by very gravelly or very cobbly Pleistocene and Pliocene deposits on high benches and terraces. The normal horizon sequence is (1) a dark-colored A1 horizon about 4 inches thick; (2) an AC horizon 2 to 4 inches thick; (3) a Cca horizon; and (4) a IICca horizon made up of very gravelly or very cobbly material.

The Judith soils are less deep to lime than the Danvers soils and lack the B2 horizon that occurs in those soils. Judith soils are deeper to very gravelly material than the Utica soils.

Typical profile of Judith clay loam (35 feet south of fence and 1,320 feet west of SW. corner of SE¼ sec. 29, T. 17 N., R. 11 E.; in pasture of native grass on slope of less than 1 percent):

A1—0 to 4 inches, dark-gray (10YR 4/1) light clay loam that is less than 5 percent gravel, very dark brown (10YR 2/2) when moist; moderate, fine, crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; very slightly calcareous; pH 8.0; clear, smooth boundary.

AC—4 to 7 inches, grayish-brown (10YR 5/2) light clay loam that is less than 5 percent gravel, dark brown (10YR 3/3) when moist; compound structure that has weak, very coarse prisms extending into the horizon below and weak, fine granules; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; only segregated lime is stalactites on underside of a few pebbles and cobblestones; pH 8.4; clear boundary.

C1ca—7 to 13 inches, light brownish-gray (10YR 6/2) clay loam that is less than 5 percent gravel, dark grayish brown (10YR 4/2) when moist; weak, very coarse prisms that separate into weak, medium and fine, subangular blocks; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; strongly calcareous; many, medium and large, white, irregular soft masses of lime flour; thick stalactites of lime on underside of pebbles and cobblestones; pH 8.4; clear boundary.

C2ca—13 to 18 inches, light-gray (10YR 7/2) clay loam, light grayish brown (10YR 6/2) when moist; strong, fine granules arranged in a weak, medium, platy structure; compact when dry; little root penetration; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; estimated calcium carbonate equivalent is 35 percent; slight difference in lime distribution visible in fine, white mottles; pebbles and cobblestones lightly coated with lime; distinct casts of lime on underside; pebbles and cobblestones make up less than 5 percent of horizon; pH 8.4; clear boundary.

C3ca—18 to 26 inches, pale-yellow (10YR 7/3) clay loam, light yellowish brown (10YR 6/4) when moist; strong, fine granules arranged in weak, medium, platy structure; compact but some roots penetrate; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; estimated calcium carbonate equivalent is 30 percent; slight difference in lime distribution visible in very fine, white mottles; pebbles and cobblestones are thinly coated with lime on upper side and thickly crusted on lower side and underneath; pebbles and cobblestones make up less than 10 percent of horizon by volume; pH 8.8; clear boundary.

IIC4ca—26 to 40 inches, white (10YR 8/2) very gravelly sandy clay loam in which pebbles make up 50 percent of horizon, by volume, and cobblestones 25 percent, light gray (10YR 7/2) when moist; massive; very compact in place; hard but not cemented when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; thick lime casts on underside of pebbles and cobblestones, some with yellow stains on stalactites; estimated calcium carbonate equivalent is 40 percent for soil particles less than 2 millimeters in size; pH 8.6; gradual boundary.

IIC5—40 to 60 inches, light-gray (10YR 7/2) very gravelly coarse sandy loam; pebbles and cobblestones make up 70 percent of horizon, by volume, pale brown (10YR 6/3) when moist; single grained; loose but compact in place; strongly calcareous; estimated calcium carbonate equivalent of fine material is 20 percent; many pebbles and cobblestones have lime casts, and many have no lime coats.

Loam, clay loam, gravelly clay loam, and cobbly clay loam occur in the survey area. Judith soils are mapped as separate units and in complexes with the Danvers, Utica, or Ashuelot soils. Also, they are mapped in undifferentiated soil groups with Raynesford and Savage soils. The A1 horizon ranges from 7.5YR to 2.5Y in hue, has chroma of 1 or 2, and for a dry soil has value of 3 to 5. Lime is disseminated throughout the Cca horizon and coats the sides and undersides of pebbles, cobblestones, and stones. The calcium carbonate equivalent ranges from 30 to 50 percent in the Cca horizon. The depth to the underlying gravel varies, but in some areas, particularly those of clay loam, this depth is uniformly 24 inches or slightly more. In some unpredictable places narrow bars of gravel are 16 to 20 inches below the surface.

LAMOURE SERIES

The Lamoure series consists of poorly drained Humic Gley soils that developed in clay loam alluvium in valleys and on terraces. A profile of Lamoure soil is identified by its dark-colored A1 horizon and its strongly calcareous, gleyed subsoil in which lime is not segregated.

The Lamoure soils lack the segregated lime that is in the subsoil of the closely associated Colvin soils. In the Lamoure soils the subsoil is more intensely gleyed than that in the better drained Gallatin soils.

Typical profile of Lamoure clay loam (about 600 feet south and 600 feet west of center of sec. 12, T. 14 N., R. 15 E.; in native pasture):

A1—0 to 10 inches, dark-gray (10YR 4/1) heavy clay loam, very dark gray (10YR 3/1) when moist; few, fine, faint, rust mottles in lower part; very weak, thin, platy structure that separates to moderate, fine and very

fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; calcareous; clear boundary.

C1g—10 to 24 inches, gray (N 5/1) clay loam containing few scattered pebbles; very dark gray (N 3/1) when moist; common, medium, distinct mottles of dark yellowish brown; very weak, thin and medium, platy structure that separates to weak, fine, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; abrupt boundary.

IIC2g—24 to 33 inches, gray (N 5/1) gravelly sandy clay loam stratified with gravelly sandy loam; very dark gray (N 3/1) when moist; mottled with dark yellowish brown; massive; calcareous; water table at 30 inches.

In the survey area Lamoure soils are mapped only in a complex with Colvin soils. The A1 horizon of Lamoure soils ranges from 10 to 15 inches in thickness. The water table generally occurs 1 to 3 feet below the surface. The depth to the gravelly material ranges from 2 to 5 feet. The ground water is held up by the underlying shale that is 6 feet or more below the surface.

LAUREL SERIES

Soils of the Laurel series developed in clay and clay loam materials on nearly level to gently sloping stream terraces and fans. They are Solonchak soils. The profile of Laurel soils is identified by (1) a very thin A2 horizon that is a light-gray crust less than 1 inch thick; (2) a very fine, blocky B2 horizon about 2 inches thick; and (3) a blocky, salty B3 horizon or upper C horizon.

The Laurel soils have thinner horizons and salts much nearer the surface than the Arvada soils.

Typical profile of Laurel clay loam (1,320 feet north and 1,520 feet east of NW. corner of SW¼ sec. 17, T. 16 N., R. 14 E.; in native pasture on a slope of 1 percent):

A2—0 to ¼ inch, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; no roots; pH 7.4; abrupt boundary.

B2—¼ inch to 2 inches, grayish-brown (2.5Y 4.6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, fine and very fine, blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; thick, distinct, continuous films of clay on all ped faces; pH 7.6; clear boundary.

B3sa—2 to 6 inches, dark grayish-brown (2.5Y 4.4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, blocky structure; hard when dry; friable when moist, very sticky and very plastic when wet; distinct, continuous films of clay on vertical faces; fine crystals of salt that are weakly calcareous; pH 7.6; clear boundary.

C1sa—6 to 10 inches, grayish-brown (2.5Y 5/2) silty clay, dark and very dark grayish brown (2.5Y 4/2 and 3/2) when moist; moderate, medium, blocky structure; hard, when dry; friable when moist, sticky and very plastic when wet; specks of salt crystals that are weakly calcareous; clay matrix; noncalcareous; distinct, continuous films of clay on vertical ped faces; pH 7.8; clear boundary.

C2sa—10 to 24 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium and coarse, blocky structure; peds very porous; some pressure faces; slightly hard when dry, friable when moist; sticky and very plastic when wet; weakly calcareous; many specks of salt crystals; distinct, continuous clay films on vertical faces, and clay patches on horizontal faces; pH 8.4; clear boundary.

C3—24 to 36 inches, light grayish-brown (2.5Y 5.7/2) silty clay loam, dark grayish brown (2.5Y 5.7/2) when moist; massive; slightly hard when dry, friable when moist, sticky and very plastic when wet; weakly calcareous; pH 8.4; clear boundary.

IIC4—36 to 44 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 5/2) when moist; massive; slightly hard when dry, firm when moist, sticky and very plastic when wet; weakly calcareous; salt crystals increase with depth, beginning at 36 inches.

In the survey area Laurel soils are mapped only in a complex with Arvada soils. The thin surface crust of Laurel soils is vesicular and massive. The B2 horizon is finer textured than the A2 horizon. In some places a thin transitional A2&B2 horizon occurs. The lower B horizon and upper C horizon have many distinct crystals of salt other than calcium carbonate. If these soils are cultivated, the upper part of the profile is destroyed and the surface layer becomes cloddy and has a dispersed appearance.

LISMAS SERIES

The Lismas series consists of shallow, fine-textured Lithosols that are underlain by clay shale. The normal horizon sequence is a thin, granular A1 horizon and a thin C horizon that merges with the parent shale at a depth of 8 to 12 inches.

The Lismas soils are shallower than the Pierre soils. They are clay throughout the profile, whereas the Midway soils are dominantly clay loam.

Typical profile of Lismas clay (approximately 1,000 feet east and 850 feet north of the SW. corner of sec. 16, T. 18 N., R. 12 E.; in native range):

A1—0 to 2½ inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; moderate, fine, granular structure; slightly hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; clear boundary.

C—2½ to 6 inches, gray (5Y 5/1) clay that contains many shale fragments; dark gray (5Y 4/1) when moist; very weak, medium to coarse blocks that break to weak, coarse plates; very hard when dry, firm when moist, very sticky and plastic when wet; few, fine pores; noncalcareous; gradual boundary.

R1sa—6 to 12 inches, thinly bedded, very dark gray clay shale that contains many masses of fine salt crystals; few roots; clear boundary.

R2—12 to 15 inches, very dark gray clay shale without visible salt crystals.

In this survey area Lismas soils are mapped in complexes with barren outcrops of shale and with the Pierre soils. In some places the Lismas soils are calcareous at the surface, but they generally are noncalcareous throughout. The color of the A1 horizon has a value of 4 to 6 when the soil is dry and of 2 to 4 when it is moist. Salt crystals are common in the lower part of the C horizon and in the upper layers of the parent shale.

LITTLE HORN SERIES

The Little Horn series consists of well-drained, loamy Chernozems on rolling upland plains high in the foothills. These soils developed in calcareous material, presumably material weathered in place from limestone, sandstone, and quartzite that is mixed to some extent with alluvium. The normal horizon sequence is a very dark colored, loamy A1 horizon; (2) a prismatic-blocky B2t horizon; (3) a Cca horizon; and (4) bedrock that is deep or moderately deep in the profile.

The Little Horn soils are redder throughout the profile than the associated Skaggs soils and have a distinct B2 horizon that is lacking in the Skaggs soils.

Typical profile of Little Horn stony loam (30 feet west and 15 feet south of center of sec. 26, T. 13 N., R. 12 E.; in native range):

A11—0 to 4 inches, loam, very dark brown (10YR 2/2) when moist; moderate, fine, crumb structure in upper part and medium, prismatic structure in lower part; soft when dry, very friable when moist; noncalcareous; pH 7.6; gradual boundary.

B1—4 to 6½ inches, loam and common boulders and pebbles of quartzite and sandstone, dark yellowish brown coated with dark brown and very dark brown (10YR 3/2, 3/3 and 10YR 2/2) when moist; moderate, medium prisms that continue through the solum and in this horizon separate into weak, medium and fine, subangular blocks; soft when dry, very friable when moist; thin, continuous clay films on prism faces; abundant roots; noncalcareous; pH 7.8; clear boundary.

B2t—6½ to 12 inches, clay loam, dark brown (7.5Y 3/3) when moist with dark brown (7.5YR 3/2) on faces of prisms; common boulders and pebbles of quartzite and sandstone; moderate, medium prisms that separate into moderate, medium and fine, subangular blocks; hard when dry, friable when moist, sticky and plastic when wet; distinct, continuous clay films on all ped faces; abundant roots; noncalcareous; pH 7.8; clear or gradual boundary.

B3ca—12 to 18 inches, light-brown (7.5YR 6/3) light clay loam, brown (7.5YR 5/3) when moist; common boulders and pebbles of quartzite and sandstone; moderate, fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; patches of clay films on ped surfaces and on pebbles in upper part of horizon; plentiful roots; strongly calcareous; lime that disseminated or occurs as lime-flour coating on pebbles; pH 8.3; clear boundary.

C1ca—18 to 30 inches, very pale brown (10YR 7/3) light clay loam, brown (10YR 5/3) when moist; mottled with common, medium, prominent, reddish-brown mottles in lower part; common boulders and pebbles of quartzite; massive; hard when dry, friable when moist; few roots; strongly calcareous; accumulated lime disseminated; pH 8.6; clear, irregular boundary.

C2—30 to 35 inches, light clay loam, mottled brown and dark reddish brown (7.5YR 5/4 and 2.5YR 4/4) when moist; common boulders and pebbles of quartzite; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; strongly calcareous; pH 8.4; abrupt boundary.

R—35 inches +, hard rock.

Stony loam is the only soil type of the Little Horn series mapped in this survey area. Coarse fragments make up 10 to 30 percent of the profile, by volume. A dark-colored B1 horizon normally underlies the A1 horizon. The A1 and B1 horizons combined range from 5 to 10 inches in thickness. In some places because lime occurs, the boundary between the B2t and B3ca horizons is clear. In other places this boundary is gradual because of a change in structure or in color. Depth to bedrock ranges from 20 to 40 inches but in most places is more than 24 inches.

LOBERG SERIES

The Loberg series consists of Gray Wooded soils that have a thick solum and developed in moderately fine textured material that weathered from shale, sandstone, and igneous rocks. The normal horizon sequence is (1) a thin layer of forest litter and humus; (2) a gray A2 horizon high in silica; (3) a B2t horizon that has blocky structure and distinct clay films on faces of peds and stones and along root channels; and (4) a C horizon consisting of slightly weathered, permeable material that was transported or weathered in place.

The Loberg soils developed in finer textured material than the Sapphire soils and have stronger structure, thicker clay films on ped faces, and more accumulated clay in the B horizon.

Typical profile of Loberg stony loam (800 feet south and 200 feet west of center of sec. 22, T. 19 N., R. 9 E.; west of pothole and aspen grove in native woodland):

O1—2 inches to 0, forest litter and humus.

A2—0 to 3 inches, light brownish-gray (10YR 6/2) loam, dark brown (7.5YR 3/2) when moist; moderate, fine, crumb structure in which peds are arranged in weak, thick plates; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; sand grains are clear and unstained; pH 5.0; clear, wavy boundary.

A2&B2—3 to 12 inches, light brownish-gray (10YR 6/2) clay loam, dark brown (10YR 3/3) when moist; moderate, medium and fine, subangular blocky structure that separates to moderate, fine, crumb structure in upper part; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; pH 5.2; clear, wavy boundary.

B2t—12 to 27 inches, pale-brown (10YR 6/3) clay, dark brown (10YR 3/3) when moist; strong, medium and fine, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; continuous, thick clay films on structural blocks and on pebbles; plentiful roots; pH 6.0; gradual, wavy boundary.

B31—27 to 49 inches, pale-brown (10YR 6/3) stony clay, dark brown (10YR 3/3) when moist; strong, medium and fine, blocky structure in upper part and moderate, medium, blocky in lower part; very hard when dry, firm when moist, very sticky and very plastic when wet; continuous, thin clay films on faces of structural blocks; pH 6.4; few roots; gradual boundary.

C1—49 to 60 inches, grayish-brown (10YR 5/2) stony clay, dark grayish brown (10YR 4/2) when moist; very weak, medium and fine, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; thin, patchy clay films on structural blocks, and thick clay films around pebbles; pH 7.4; abrupt boundary.

C2—60 to 72 inches, dark grayish-brown (10YR 4/2) stony clay, very dark grayish brown (10YR 3/2) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; thin clay films around pebbles; few, fine pores; pH 7.8.

Only stony loam is mapped separately in the survey area, but Loberg soils are also mapped in a complex with Sapphire soils. In some profiles of Loberg soils, material from the A2 horizon tongues into the B2 horizon to a depth of as much as 24 inches. The B and C horizons range from clay to sandy clay loam and have a clay content of 35 to 50 percent. In some places the A2&B2 horizon has abundant clear grains of sand that thickly coat peds in the upper part of the horizon and form irregular streaks in the lower part. In these places the subangular blocks in the A2&B2 horizon are distinctly coated with clay, and pebbles are continuously coated. Stone content ranges from nearly stone-free to about 50 percent. Depth to bedrock is generally greater than 40 inches.

MAGINNIS SERIES

Soils of the Maginnis series are dark-colored, noncalcareous clay loams that developed in weathered hard shale and sandstone. They are Chestnut soils that intergrade toward Lithosols. The normal horizon sequence is (1) an A1 horizon about 4 inches thick; (2) a blocky transitional BR horizon that has clay films on ped faces and on fragments of shale and other rock; and (3) bedrock near the surface.

The Maginnis soils are shallower than the associated Absarokee and Alder soils, which do not have a very gravelly or very channery transitional horizon between the A1 and R horizons.

Typical profile of Maginnis clay loam (1,200 feet north and 1,020 feet east of the SW. corner of sec. 16, T. 15 N., R. 13 E.; in native pasture):

A1—0 to 4 inches, grayish-brown (2.5YR 5/2) clay loam, very dark grayish brown (2.5YR 3/2) when moist; weak, very fine, granular structure, and moderate, fine, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; plentiful roots; noncalcareous; pH 7.3; gradual boundary.

BR—4 to 16 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam and thinly stratified, weathered black shale and cherty sandstone that increases in lower part; very dark grayish brown (2.5Y 3/2) when moist; moderate, fine and very fine, blocky structure; hard when dry, friable when moist, very sticky and very plastic when wet; distinct, continuous clay films on all ped faces and on chert fragments; plentiful roots; noncalcareous; pH 7.4; abrupt boundary.

R—16 to 22 inches +, fractured, gray cherty sandstone with clay and clayey shale between the fractures; thick, distinct, continuous clay films on fragments of shale and sandstone.

Maginnis cobbly clay loam is mapped separately in the survey area, and Maginnis soils are mapped in complexes with Absorakee and Alder soils.

The A1 horizon is generally channery and ranges from 2 to 4 inches in thickness. Its color in dry soils is 10YR or 2.5Y in hue, 5 to 3 in value, and 2 or 1 in chroma. Clay films on peds and on fragments of shale and other rock range from thick and continuous to only patches. The clay content of the BR horizon ranges from only a trace more than that of the A1 horizon to enough to make the BR horizon a textural class finer than the A1 horizon. In some profiles there is a thin B2 horizon as well as a BR horizon. In the thinner profiles a transitional AC horizon replaces the BR horizon. Fragments of shale and sandstone make up 50 to 90 percent of the soil volume of the transitional B2, BR, or AC horizon. Depth to the R horizon ranges from 8 to 18 inches. Deep or moderately deep in the profile, thin coatings of lime are on the sides of crevices and under plates of shale and other rock.

MIDWAY SERIES

The Midway series consists of moderately fine textured, calcareous Lithosols that developed over clay loam shale interbedded with soft sandstone. The normal horizon sequence is (1) a thin, slightly dark A1 horizon; (2) a transitional AC or C horizon; and (3) bedrock near the surface.

The Midway soils are finer textured than the Bainsville soils, which develop from loam shale and from sandstone. They are coarser textured than the Lismas soils, which developed from clay shale.

Typical profile of Midway clay loam (1,400 feet west and 300 feet south of the NE. corner of sec. 4, T. 18 N., R. 11, E.; in native pasture):

A1—0 to 3 inches, brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; weakly calcareous; pH 8.6; clear boundary.

AC—3 to 5 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) when moist; weak, thin, platy structure; weathered sandstone fragments; soft when dry, friable when moist, sticky and plastic when wet; plentiful roots; weakly calcareous; pH 8.6; abrupt boundary.

CR—5 to 9 inches, light olive-brown (2.5Y 5/3) clay loam containing weathered soft shale and sandstone; plentiful roots; calcareous; pH 8.6; gradual boundary.

R1—9 to 17 inches, light olive-brown (2.5Y 5/3), weathered, platy, soft sandstone and shale with coats of lime on underside; strongly calcareous; pH 8.8; gradual boundary.

R2—17 inches +, soft weathered sandstone and shale.

Clay loam is the dominant type of the Midway series in the survey area. The A1 horizon has hue of 10YR or 5Y, and value of 5 or 6 when dry and 3 or 4 when moist. Depth to the virtually unweathered bedrock ranges from about 8 to 20 inches.

PIERRE SERIES

Soils of the Pierre series developed in place from clay shale. They are Chestnut soils. The normal horizon sequence of Pierre soils is (1) a granular A11 horizon about 3 inches thick; (2) a prismatic-blocky A12 horizon about 3 inches thick; (3) an AC horizon about 6 inches thick; (4) a Cca or Csa horizon; and (5) underlying shale that is shallow or moderately deep in the profile.

The upper horizons of the Pierre soils are lighter colored than those of the Castle soils. Pierre soils are deeper to shale than the associated Lismas soils and are shallower to shale than the associated Promise soils.

Typical profile of Pierre clay (1,100 feet north and 600 feet east of SW. corner of SE¼ sec. 20, T. 17 N., R. 13 E.; in native range):

A11—0 to 2 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, thin, platy structure and weak, fine, granular structure; slightly hard when dry, firm when moist, very sticky and very plastic when wet; abundant roots; weakly calcareous; pH 7.4; clear boundary.

A12—2 to 6 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium and fine, blocky structure; hard when dry, very firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 7.6; plentiful roots; clear boundary.

AB—6 to 13 inches, grayish-brown and dark grayish-brown (2.5Y 5/2 and 4/2) clay, dark grayish brown and very dark grayish brown (2.5Y 4/2 and 3/2) when moist; weak, medium and coarse prisms that break to moderate, medium and fine blocks; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; faint splotches and threads of lime; pH 8.0; plentiful roots; clear boundary.

Bca—13 to 26 inches, light brownish-gray (2.5Y 6/2) clay with common, fine, distinct mottles of grayish brown (2.5Y 5/2) when dry; dark grayish brown (2.5Y 4/2) and dark gray (N 4/0) when moist; weak, coarse, prismatic structure that breaks to moderate, medium and coarse, blocky structure; prominent shale fragments inside peds; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; faint splotches of lime; pressure faces; pH 8.2; few roots; clear boundary.

CR—26 to 32 inches, light grayish-brown and light-gray (2.5Y 6/2 and 7/2) clay with common, fine, distinct mottles of light olive brown (2.5Y 5/6) when dry, dark grayish brown and light gray (2.5Y 4/2 and 7/2) when moist; weak, medium and coarse, blocky structure; peds coated with fine crystals of gypsum or other salts; hard when dry, firm when moist, very sticky and very plastic when wet; distinct pressure faces; strongly calcareous; pH 8.2; few roots; clear boundary.

R—32 to 36 inches, thinly stratified gray and yellowish clay shale containing mica chips; weakly calcareous; nests of salt crystals; pH 8.4; few roots.

Clay is the dominant type of the Pierre series in the survey area. The soil has a hue of 2.5Y and when it is dry its value is 4.5 to 5.5 in the surface horizon and 5 or 6 in the lower subsoil. Chroma is 2 or 3. These soils commonly have some segregated lime and some crystals of gypsum or other salts in their C horizon or in the upper layers of shale. Depth to shale ranges from 15 to 30 inches. These soils are commonly weakly calcareous at the surface.

PROMISE SERIES

The Promise series are well-drained Chestnut soils. These soils developed in clay on terraces, benches, and mantled uplands. The clay that occurs in most areas is alluvium, but that on the bench east of Arrow Creek presumably is partly windblown material that was blown from breaks along Arrow Creek. The normal horizon sequence is (1) a fine, granular A11 horizon about 3 inches thick; (2) a coarse to medium, granular A12 horizon about 3 inches thick; (3) an AC horizon about 6 inches thick; (4) a C horizon; and (5) a Cca horizon that grades to massive clay or clay shale.

The Promise soils are more than 30 inches deeper to shale than the Pierre soils. They have a lighter colored A1 horizon than the Castle soils, which occur at higher elevations.

Typical profile of Promise clay (600 feet west and 300 feet north of the NW. corner of SW¼ sec. 36, T. 17 N., R. 12 E.; 410 feet east of bridge on Coyote Creek on south side of road in native pasture):

A11—0 to 2½ inches, dark-gray (2.5Y 4/1) light clay, very dark gray (2.5Y 3/1) when moist; moderate, fine, granular structure; hard when dry, firm when moist, very sticky and very plastic when wet; plentiful roots; noncalcareous; pH 8.0; clear boundary.

A12—2½ to 6 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, granular structure that breaks to moderate, medium, granular structure; distinct, continuous clay films on all ped faces; hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.2; plentiful roots; clear boundary.

A13—6 to 13 inches, very dark grayish-brown (2.5Y 3/2, dry and moist) clay containing a few pebbles coated with lime on underside; moderate, medium and coarse, prismatic structure that breaks to moderate, fine and medium, angular blocky structure; thick, distinct, continuous clay films on all ped faces; very hard when dry, firm when moist, very sticky and very plastic when wet; roots follow the cleavage faces of the prisms; noncalcareous; pH 8.4; gradual boundary.

B2—13 to 21 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic structure that breaks to moderate, medium and coarse, blocky structure; distinct, continuous clay films on all ped faces that are broken only by faint splotches of lime; very hard when dry, firm when moist, very sticky and very plastic when wet; plentiful roots; weakly calcareous; pH 8.6; clear boundary.

Abca—21 to 31 inches, grayish-brown and dark grayish-brown (2.5Y 5/2 and 4/2) clay, dark grayish brown and very dark grayish brown (2.5Y 4/2 and 3/2) when moist; moderate, medium prisms that break to strong, coarse and medium blocks; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; moderately calcareous; prominent white splotches of pure calcium carbonate; distinct pressure faces; plentiful roots; pH 9.0; gradual boundary.

Cca—31 to 40 inches, grayish-brown and gray (2.5Y 5/2) clay with common, medium, faint mottles of gray (N 5/0), dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, blocky structure; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; prominent pressure faces; weakly calcareous; lime splotches less prominent than in horizon above; few roots; pH 9.0; gradual boundary.

R—40 to 48 inches, clay loam shale; some lime threads; pH 8.8.

Clay is the dominant type of the Promise series in the survey area, but small areas of cobbly clay occur. The finest textured subsoil horizon has as much as 5 percent more clay than the A1 horizon. These soils are weakly calcareous at the surface or are noncalcareous to a depth of 10 inches. The soil has a hue yellower than 10YR. In a dry soil the value is 3 or 4 in the A horizon and 4 to 6 in the C horizon. In the uplands shale underlies these soils at a depth of 2½ to 4 feet, but on the terrace benches shale is at a depth of more than 5 feet. Gypsum salts are common in the lower subsoil or in the shale substratum. In some places the shale bedrock has strata of bentonite and crystals of salt.

RAYNESFORD SERIES

The Raynesford series consists of well-drained, very dark colored, loamy Calcisols on fans, terraces, and foot slopes in the foothills. The identifying profile characteristics of Raynesford soils are a very dark colored, moderately thick A1 horizon and a light-colored Cca horizon about 17 inches from the surface.

The Raynesford soils have a thinner A1 horizon than the Adel soils and are shallower to strong accumulations of lime. They lack the limestone and limy shale substratum of the Skaggs soils.

Typical profile of Raynesford loam (1,000 feet north of center of sec. 11, T. 14 N., R. 11 E.; approximately 150 feet west of county road in native pasture):

A11—0 to 3 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, fine, crumb structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 7.8; clear boundary.

A12—3 to 11 inches, very dark gray (10YR 3/1) heavy loam, black (10YR 2/1) when moist; very weak, medium, blocky structure to massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 8.0; plentiful roots; abrupt boundary.

A13ca—11 to 17 inches, gray (10YR 5/1) loam containing a few rounded pebbles of limestone and small particles of shale; dark gray (10YR 4/1) when moist; very weak, medium, blocky structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; strongly calcareous; pH 8.2; gradual boundary.

Cca—17 to 40 inches, light-gray (10YR 6/1), gritty heavy loam containing small particles of green shale and fragments of limestone; gray (10YR 5/1) when moist; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; very strongly calcareous; pH 8.6.

Loam and stony loam are the most extensive types of the Raynesford series in the survey area. Loam is dominant. These soils generally occur closely with the Adel soils. Soil colors dominantly have a 10YR hue. Lime is accumulated as coats around pebbles, as films and seams, and as soft concretions.

RHOADES SERIES

The Rhoades series consists of Solonetz soils that are underlain by shale or interbedded shale and sandstone on the uplands. In the survey area these soils are solodized. The normal horizon sequence is (1) an A1 horizon about 6 inches thick; (2) a thin A2 horizon; (3) a clay B2t

horizon that has columnar structure in upper part and blocky structure in lower; and (4) accumulation of lime, salts, or both in the upper part of the bedrock at a depth of 18 to 24 inches.

The shale substratum is closer to the surface in the Rhoades soils than in the Beckton soils, which do not have shale within 5 feet of the surface.

Typical profile of Rhoades loam (800 feet south and 1,300 feet east of the NW. corner of SW¼ sec. 8, T. 18 N., R. 10 E.; in native pasture):

A11—0 to 1 inch, gray (10YR 5/1) loam, dark gray (10YR 4/1) when moist; platy structure; soft when dry, very friable when wet, sticky and plastic when moist; noncalcareous; pH 6.8; clear boundary.

A12—1 inch to 7 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium, blocky structure; soft when dry, very friable when moist, sticky and plastic when wet; abundant roots; noncalcareous; pH 7.0; clear boundary.

A2—7 to 8 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium platy structure; soft when dry, very friable when moist, sticky and plastic when wet; plentiful roots; noncalcareous; pH 7.0; abrupt boundary.

B21t—8 to 11 inches, light olive-brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) when moist; moderate, medium and fine, columnar structure that breaks to moderate, medium and fine, blocky structure; thick, distinct, continuous clay films on all faces; hard when dry, firm when moist, sticky and plastic when wet; plentiful roots; noncalcareous; pH 7.2; clear boundary.

B22t—11 to 20 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, angular blocky structure; very thick, distinct, continuous clay films on all faces of peds; very hard when dry, very firm when moist, sticky and plastic when wet; plentiful roots; noncalcareous; pH 7.2; abrupt boundary.

R1ca—20 to 24 inches, fractured, hard cherty sandstone that has clay in fractures; distinct clay films on upper side of rocks and on clay in fractures; moderately thick coats of lime on underside of rock.

R2—24 inches, fractured cherty sandstone not coated with lime.

The Rhoades soils in this survey area are mapped in complexes with the Arvada soils and with Winifred soils. Loam is the dominant type. The A1 and A2 horizons combined range from 4 to 8 inches in thickness. The B2t horizon is nearly neutral to moderately saline but is generally nearly neutral. Bedrock ranges from interbedded hard shale and sandstone to clay shale. Generally, lime is accumulated on the underside of fragments of shale and other rock in the upper part of the substratum, but where the bedrock is shale, some profiles are noncalcareous and have salt crystals instead of lime.

SAPPHIRE SERIES

The Sapphire series consists of well-drained, loamy Gray Wooded soils that developed in material weathered in place from sandstone. The normal horizon sequence is (1) a thin layer of forest litter and humus; (2) a gray A2 horizon that is high in silica; (3) a blocky B2 horizon in which clay is accumulated as films on ped faces, in root channels, and on rock fragments; and (4) shattered, slightly weathered sandstone moderately deep in the profile.

The Sapphire soils developed in coarser textured material than the Loberg soils. Unlike the B horizon of Loberg soils, the B horizon of Sapphire soils does not contain much more clay than the A1 horizon. Sapphire soils have an A2 horizon instead of the thick A1 horizon of the Teton soils. The Teton soils developed in grassland.

Typical profile of Sapphire loam (600 feet south and 200 feet east of NW. corner of SW¼ sec. 15, T. 19 N., R. 9 E.; in native stand of lodgepole pine, Douglas-fir, snowberry, and Oregon grape):

O1—1 inch to 0, forest litter and humus.

A2—0 to 3½ inches, light brownish-gray (10YR 6/2) loam, dark brown (10YR 3/3 moist); moderate, medium, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; very slightly stained, clear sand grains; abundant roots; pH 6.2; clear, wavy boundary.

A2&B2—3½ to 8 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2.5) when moist; weak, coarse, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; patches of clay films on a few peds that have clear, unstained grains of sand; plentiful roots; pH 6.4; clear, wavy boundary.

B2&A2—8 to 13 inches, light brownish-gray (10YR 6/2) light clay loam with a few, medium, faint mottles of grayish brown (10YR 5/2), brown (10YR 4/3) when moist; moderate, medium and coarse, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; distinct, continuous clay films on peds that are thickly coated with clear sand grains; few roots; pH 6.6; gradual, wavy boundary.

B2t—13 to 20 inches, light brownish-gray (10YR 6/2) light clay loam, grayish brown (10YR 5/2.5) when moist; moderate, medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; peds with distinct clay films and thick coats of clear sand; thick clay films on upper faces of rock fragments; few roots; pH 6.6; clear, wavy boundary.

R1—20 to 38 inches, shattered hard sandstone in which sand is between ledges and fractures and makes up 15 to 20 percent of horizon, by volume; patches of thick clay films on upper and under sides of sandstone fragments; noncalcareous; gradual boundary.

R2—38 to 45 inches, shattered horizontally bedded sandstone in which loamy fine sand is between ledges and makes up less than 5 percent of horizon; patches of thick clay films on faces of sandstone; noncalcareous.

Stony loam and loam are the dominant types of the Sapphire series in this survey area. Some profiles have a very thin A1 horizon, but generally an A2 horizon is the top mineral soil. The color of a moist A2 horizon has hue redder than 2.5Y and yellower than 5YR, chroma of 2 or 3, and value of 3 or 4. The color of a moist B horizon has the same range in the hue as the A2 horizon, chroma of 2 to 5, and value of 4 or 5. The B2 horizon has a weak to moderate, blocky structure and distinct, patchy to continuous clay films on ped faces, in root channels, and on rock fragments. It contains 5 to 20 percent more clay than the A2 horizon. Depth to hard sandstone ranges from 18 to 30 inches.

SAVAGE SERIES

The Savage series consists of deep, well-drained Chestnut soils that developed in silty clay loam or poorly graded clay loam materials. Profile characteristics that identify Savage soils are (1) a dark A1 or Ap horizon; (2) a heavy silty clay loam or silty clay B2t horizon that has prismatic-blocky structure and continuous clay films on ped faces; and (3) a Bca horizon that grades to massive, calcareous material.

The grayish-brown color of the Savage soils distinguishes them from the reddish-colored Fergus soils. The Savage soils have less prominent accumulations of lime in their carbonate horizon than have the Danvers soils and lack the very gravelly substratum of those soils. The B2t horizon and its continuous clay films on ped faces dis-

tinguishes the Savage soils from the Straw soils, which have few, if any, clay films. Also, Straw soils have only slightly more clay in the B2 horizon, if one occurs, than in the A1 horizon.

Typical profile of Savage silty clay loam (900 feet east and 60 feet south of the NW. corner of NE¼ sec. 26, T. 16 N., R. 12 E.; in field of stubble):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, granular structure; soft when dry, friable when moist, sticky and plastic when wet; pH 7.4; abundant roots; abrupt boundary.

B21t—6 to 14 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, prismatic structure that breaks to strong, medium and coarse, blocky structure; slightly hard when dry, friable when moist, very sticky and very plastic when wet; thick, distinct, continuous clay films on all faces; pH 7.6; abundant roots; clear boundary.

B22—14 to 19 inches, grayish-brown to light grayish-brown (10YR 5/2 and 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium and coarse, prismatic structure that breaks to strong, coarse and fine, blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; distinct, continuous clay films and heavy coats of sand on faces of peds; pH 8.4; plentiful roots; clear boundary.

B3ca—19 to 26 inches, light brownish-gray and white (10YR 6/2 and 8/1) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse to fine, blocky structure; soft when dry, friable when moist, sticky and plastic when wet; strongly calcareous; lime splotches broken only by clay; heavy concentration of lime in gravel sockets; distinct, continuous clay film on vertical faces; pH 8.8; few roots; clear boundary.

C—26 to 32 inches +, grayish-brown and white (10YR 5/2 and 8/1) gravelly clay loam, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, friable when moist, sticky and plastic when wet; strongly calcareous; pH 8.6.

Silty clay loam is the dominant type of the Savage series in this survey area, but small areas of silty clay occur. The A1 or Ap horizon has hue of 2.5Y or 10YR, chroma of 2 or 3, and value of 5 or less when dry and 4 or less when moist. Structure of the B2 horizon ranges from weak to strong prismatic and moderate to strong blocky. Thick and moderately thick clay films are on the peds. Depth to accumulated lime ranges from 10 to 24 inches. In some areas pebbles make up 10 to 20 percent of the lower C horizon.

SKAGGS SERIES

Soils of the Skaggs series are Calcisols that are very dark colored, well drained, and loamy. They developed high in the foothills in strongly calcareous material that weathered in place from limestone, limy shale, or limy sandstone that is mixed in places with alluvium. The normal horizon sequence of Skaggs soils is (1) a very dark colored A1 horizon; (2) a light-colored Cca horizon, and (3) bedrock that is generally moderately deep in the profile.

Skaggs soils are deeper to bedrock than the Duncom soils, which are shallow or very shallow Lithosols. They are not so deep as the Raynesford soils, which are 5 feet or more to bedrock. The Skaggs soils lack the distinct B2 horizon of the Little Horn soils.

Typical profile of Skaggs clay loam (1,400 feet south and 1,320 feet east of the NW. corner of sec. 6, T. 16 N., R. 8 E.; in native pasture):

A11—0 to 2 inches, very dark brown (10YR 2/2) light clay loam, black (10YR 2/2) when moist; weak, fine, crumb structure; soft when dry, friable when moist, nonsticky and slightly plastic when wet; noncalcareous; pH 6.8; abundant roots; clear boundary.

A12—2 to 7 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, blocky structure; slightly hard when dry, friable when moist; slightly sticky and slightly plastic when wet; thin, patchy clay films on vertical faces in lower part; noncalcareous; pH 7.0; plentiful roots; clear boundary.

Cca—7 to 20 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium and fine, blocky structure; slightly hard when dry, friable when moist, sticky and slightly plastic when wet; thin clay films on vertical faces; strongly calcareous; many threads of lime; pH 8.0; clear boundary.

R—20 to 34 inches, soft, greenish shale containing hard and soft chunks of greenish, slaty material; very strongly calcareous; uniformly streaked with lime.

Loam, clay loam, and stony clay loam are mapped in the survey area. Skaggs clay loam is dominant. The A1 horizon of a dry soil has hue of 10YR, value of 4 to 2, and chroma of 1 or 2. Lime is segregated in streaks, in coats around and under stone fragments, and as lime flour disseminated unevenly through the soil. The thickness of the A1 horizon ranges from as much as 8 inches on the milder slopes to as little as 3 inches on steeper, convex slopes. In some areas of alluvium the depth to bedrock is as much as 4 feet, but in most places bedrock is at a depth of 18 to 36 inches.

SLOCUM SERIES

The Slocum series consists of deep, imperfectly drained, noncalcareous soils on small fans and in narrow valleys in the foothills of the Highwood Mountains. These soils developed from weathered igneous rock and sandstone. They are Chernozems that intergrade toward Alluvial soils. The identifying characteristics of Slocum soils are (1) a thick, dark-colored A1 horizon; (2) a lighter colored C horizon that is slightly gleyed, slightly mottled, or both; and (3) a noncalcareous profile.

Unlike the calcareous Gallatin soils, Slocum soils are noncalcareous.

Typical profile of Slocum loam (approximately 1,400 feet west and 600 feet south of NE. corner of SE¼ sec. 22, T. 19 N., R. 9 E.; in aspen grove):

A11—0 to 2 inches, very dark brown (10YR 2/2) light clay (10YR 2/1) when moist; moderate, medium, crumb structure that breaks to weak, coarse and medium, blocky structure; soft when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 5.0; abundant roots; clear, wavy boundary.

A12—10 to 16 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 5.0; abundant roots; krotovinas occur; clear, irregular boundary.

C1—16 to 24 inches, light brownish-gray (10YR 6/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, blocky structure; hard when dry, firm when moist, sticky and plastic when wet; pH 5.0; noncalcareous; abundant roots; clear, wavy boundary.

C2g—24 to 33 inches, light brownish-gray (10YR 6/2) silty clay loam, very dark gray (10YR 3/1) when moist;

weak, blocky structure; hard when dry, friable when moist, slightly sticky, slightly plastic when wet; pH 5.0; noncalcareous; common roots; clear boundary.

C3g—33 to 40 inches, gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; pH 5.0; noncalcareous; water table at 33 inches.

Slocum loam is the only Slocum soil mapped in the survey area. Its A1 horizon ranges from 12 to 18 inches in thickness. Pebbles are scattered through the profile in places. Depth to the water table generally ranges from 3 to 5 feet.

SPRING CREEK SERIES

Soils of the Spring Creek series developed in loamy material that weathered in place from igneous rock. They are Lithosols. The normal horizon sequence of Spring Creek soils is (1) a dark A1 horizon; (2) a strongly calcareous C horizon, Cca horizon, or both; and (3) igneous rock or metamorphic rock near the surface.

Although bedrock is at about the same depth in the Spring Creek, Cheadle, and Duncom soils, Spring Creek soils are distinguished from the Cheadle and Duncom soils by the kind of bedrock. Igneous or metamorphic rock underlies the Spring Creek soils, but hard sandstone underlies the Cheadle soils and limestone underlies the Duncom soils. The Spring Creek soils lack the well-defined B2 horizon of the associated Blaine and Woodhurst soils.

Typical profile of Spring Creek stony loam (500 feet south and 400 feet east of NW. corner of NE¼ sec. 4, T. 18 N., R. 11 E.; in native pasture near a dike of igneous rock):

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) stony heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft when dry, friable when moist, sticky and plastic when wet; pH 7.2; noncalcareous; abundant roots; clear boundary.

AC—6 to 10 inches, grayish-brown (10YR 5/2) fine gravelly clay loam, dark gray (10YR 4/1) when moist; moderate, fine, granular structure; soft when dry, friable when moist, sticky and nonplastic when wet; very strongly calcareous; lime casts on underside of pebbles; pH 8.0; plentiful roots; gradual boundary.

Cca—10 to 14 inches, light-gray (10YR 7/2) fine gravelly clay loam, light grayish brown (10YR 6/2) when moist; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; very strongly calcareous; pH 8.0; few roots; clear boundary.

R1ca—14 to 18 inches, well-weathered, crumbly, basic igneous rock specked and filmed with white lime; clear boundary.

R2—18 inches, hard, basic igneous rock.

Stony loam is the dominant type of the Spring Creek series in this survey area. Spring Creek loam is mapped with Blaine loam in a complex. The A1 horizon ranges from 3 to 10 inches in thickness and is generally noncalcareous. A dry A1 horizon has hue of 10YR, chroma of 2 or 3, and value of 3 to 5. Rock fragments below the A1 horizon are generally coated with lime on their underside, and lime is disseminated throughout the C horizon. Lime also occurs in fractures of the bedrock. Depth to bedrock ranges from 6 to 20 inches.

STRAW SERIES

The Straw series consists of well-drained Chestnut soils that developed in loam and clay loam, calcareous material on fans and stream terraces in the lower foothills and in the plains section of the survey area. The normal horizon sequence of the Straw soils is (1) a dark A horizon 5 to 10 inches thick; (2) a slightly lighter colored B2 or AC horizon 4 to 10 inches thick; and (3) a C horizon containing faint to distinct segregations of lime in films and in threads.

The grayish-brown color of the Straw soils distinguishes them from the reddish-colored Twin Creek soils. Unlike the Savage soils, the Straw soils lack the continuous clay films on peds and the distinctly higher clay content in the B2 horizon than in the A1.

Typical profile of Straw clay loam (approximately 1,320 feet south and 1,000 feet east of center of sec. 26, T. 16 N., R. 11 E.; under fence 0.2 mile north of corral, 250 feet east of Wolf Creek, and 130 feet north of crossing):

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) when moist; weak medium and fine, crumb structure in upper few inches and weak, medium, prismatic structure below; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.4; clear boundary.

AC—9 to 15 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, prismatic structure; thin, patchy clay films; hard when dry, friable when moist; calcareous; lime disseminated in weak threads; pH 8.6; gradual boundary.

C1—15 to 25 inches, grayish-brown (10YR 5/2) light clay loam that is about 5 percent gravel; very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure that breaks to weak, coarse, blocky structure; hard when dry, friable when moist; calcareous; lime segregated in weak threads; pH 8.8; gradual boundary.

C2—25 to 50 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; common, fine, faint mottles of dark brown and dark reddish brown; massive; medium and fine pores; slightly hard when dry, friable when moist; calcareous; pH 8.8.

Straw clay loam and Straw clay loam, gravelly substratum, are mapped in this survey area. The A1 horizon is weakly calcareous or noncalcareous. Its color in a dry soil has hue of 10YR and 2.5Y, value of 5 to 3, and chroma of 1 or 2. Lime is faintly to distinctly segregated in films and threads. Dark-colored buried soil layers are common and vary in texture.

TERRAD SERIES

The Terrad series consists of well-drained, clayey Chestnut soils. These soils developed in reddish-colored, calcareous clay that weathered in place from clay shale, or in alluvium derived from clay shale. The profile of Terrad soils is characterized by (1) a granular A1 or Ap horizon about 4 inches thick; (2) a prismatic-blocky clay B2 horizon; and (3) slight to moderate amounts of segregated lime in lower subsoil.

The Terrad soils are finer textured throughout the profile than the Fergus and Darret soils, and they are deeper to shale than the Darret soils. Their reddish color distinguishes them from the Promise soils.

Typical profile of Terrad clay (600 feet west and 200 feet north of SE. corner of sec. 7, T. 17 N., R. 9 E.; in native pasture):

A1—0 to 4 inches, reddish-gray (5YR 5/2) light clay, dark reddish brown (5YR 3/2) when moist; moderate, fine, granular structure; soft when dry, friable when moist, sticky and plastic when wet; pH 6.1; abundant roots; clear boundary.

B21—4 to 9 inches, dark reddish-gray (5YR 4/2) clay, dark reddish brown (5YR 3/3) when moist; strong, fine, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all faces; pH 6.1; plentiful roots; clear boundary.

B22—9 to 16 inches, dark reddish-gray (5YR 4/2) clay, very dark reddish brown (5YR 3/2) when moist; moderate, coarse, prismatic structure and strong, medium, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all faces; plentiful roots that are thickest along structure faces; pH 7.2; gradual boundary.

B23ca—16 to 36 inches, weak-red (2.5YR 4/2) clay, dark reddish brown (2.5YR 3/4) when moist; strong, coarse, angular blocky structure in upper part and weak, coarse, angular in lower part; few pressure faces; extremely hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all ped faces; few large nodules of segregated lime; pH 8.1; few roots; gradual boundary.

B3—36 to 49 inches, weak-red (2.5YR 4/2) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium and coarse, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on vertical faces, and patches on horizontal faces; weakly calcareous; pH 7.8; clear, wavy boundary.

R—49 to 59 inches, weak-red (10YR 5/2) clay shale mixed with gray shale, reddish gray (10R 5/1) when moist; hard when dry; firm when moist, sticky and plastic when wet; weakly calcareous; pH 7.9; very few roots.

Terrad clay and Terrad silty clay are mapped in the survey area. The color of the A1 horizon has hue of 7.5YR to 2.5YR and chroma of 2 to 4; value is 3 to 5 for a dry soil and 2 or 3 for a moist one. The B2 horizon has hue of 5YR to 10R and contains 5 to 20 percent more clay than the A horizon. The noncalcareous solum ranges from 10 to 30 inches in thickness. The amount of segregated lime in the B23ca horizon ranges from few to many nodules. Depth to clay shale ranges from 24 to 50 inches on the uplands and is more than 5 feet on the terraces.

TETON SERIES

The Teton series consists of well-drained, noncalcareous soils that developed in loamy material. Presumably, this material weathered in place from sandstone in the foothills. These soils are Chernozems. The profile of Teton soils is characterized by (1) a thick, black or very dark brown A1 horizon that is high in organic-matter content; (2) a lighter colored B2 horizon that has blocky structure and clay films on peds, but not noticeably more clay than the A1 horizon; (3) soil development extending into fine material in fractures of bedrock; and (4) bedrock at an average depth of about 30 inches.

Typical profile of Teton loam (1,420 feet north and 220 feet west of SW. corner of SE¼ sec. 9, T. 16 N., R. 9 E.; in native pasture):

A11—0 to 5 inches, black (10YR 2/1, dry and moist) loam; moderate, fine, crumb structure; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; pH 6.3; mat of fine roots; clear boundary.

A12—5 to 9 inches, very dark brown (10YR 2/2) clay loam, black (10YR 2/1) when moist; weak, medium and fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; pH 5.7; abundant roots; clear boundary.

B1—9 to 15 inches, very dark grayish-brown (10YR 3/3) clay loam and pebbles and cobblestones that make up 15 percent of the horizon, by volume; very dark brown (10YR 2/2) when moist; moderate, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; patches of clay films on vertical faces; pH 5.8; abundant roots; clear, wavy boundary.

B21—15 to 22 inches, brown (10YR 5/3) clay loam and angular pebbles and cobblestones that make up about 15 percent of horizon, by volume; strong, fine, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all faces; noncalcareuos; pH 6.0; plentiful roots; gradual boundary.

B22—22 to 31 inches, brown (10YR 5/3) clay loam and angular pebbles and cobblestones that make up about 15 percent of horizon, by volume; dark brown (10YR 4/3) when moist; strong, medium and fine, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all faces; noncalcareous; pH 6.2; plentiful roots; gradual boundary.

B3—31 to 47 inches, brown (10YR 5/3) clay loam and angular pebbles and cobblestones that make up 50 to 60 percent of horizon, by volume; strong, medium and fine, subangular blocky structure; hard when dry, firm when moist, sticky and very plastic when wet; continuous, distinct clay films on all faces of peds; noncalcareous; pH 6.6; few roots; clear, wavy boundary.

R—47 inches +, sandstone; strongly calcareous at 52 inches.

Teton loam, stony loam, and channery loam occur in the survey area. Hue is 10YR throughout the profile. The A1 horizon has value of 3 or less when it is dry. When dry, the B2 horizon has value of 3 to 5 and chroma of 2 to 4. The profile is generally noncalcareous throughout, but in some areas at a depth of 30 inches or more, it is calcareous and has faint to distinct segregations of lime. Depth to bedrock ranges from 24 to 50 inches.

TWIN CREEK SERIES

The Twin Creek series consists of well-drained Chestnut soils that developed in deep, reddish-colored, calcareous loam and clay loam on fans and stream terraces in the foothills. The normal horizon sequence of Twin Creek soils is (1) a dark A horizon 5 to 8 inches thick; (2) a lighter colored loam B2 horizon 10 to 20 inches thick; and (3) a calcareous, loamy C horizon containing faint to distinct lime segregations in films and threads.

The Twin Creek soils are coarser textured throughout their profile than the Fergus soils and, unlike those soils, do not have thick, continuous clay films on peds of the B2 horizon or much more clay in the B2 horizon than in the Ap horizon. The reddish color of the Twin Creek soils distinguishes them from the yellower Straw soils.

Typical profile of Twin Creek loam (400 feet north of SW. corner of SE¼ sec. 32, T. 18 N., R. 8 E.; in alfalfa hayfield):

Ap—0 to 6 inches, dark-brown (7.5YR 4/2) loam, very dark brown (7.5YR 2/2) when moist; weak, thick and medium, platy structure; soft when dry, friable when moist; noncalcareous; pH 7.0; abundant roots; abrupt boundary.

A3—6 to 10 inches, dark-brown (7.5YR 4/2) loam, very dark brown (7.5YR 2/2) when moist; weak, medium, prismatic structure that breaks to weak, medium, blocky structure; continuous, distinct clay films on vertical faces and patches on horizontal faces; slightly hard when dry, friable when moist; noncalcareous; pH 7.0; clear boundary.

B2—10 to 28 inches, dark reddish-gray (5YR 4/2) loam, dark reddish brown (5YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, coarse, blocky structure; patches of clay films on vertical faces;

hard when dry, friable when moist; sandstone fragments in lower part; noncalcareous; pH 7.2; plentiful roots; clear boundary.

A1bca—28 to 40 inches, dark-brown (7.5YR 3/2) light clay loam, very dark brown (7.5YR 2/2) when moist; weak, medium and coarse, blocky structure; hard when dry, friable when moist; weakly calcareous; many threads of lime; pH 8.0; clear boundary.

Cbca—40 to 46 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 4/2) when moist; massive; slightly hard when dry, friable when moist; strongly calcareous; many threads of lime; pH 8.6; few small fragments of sandstone.

Twin Creek loams and a clay loam are mapped separately in the survey area. In some profiles a transitional AC horizon replaces the B2 horizon. The depth to lime segregation ranges from 18 to 30 inches. These soils normally are free of sandstone fragments except in some small steep areas where 20 percent of the lower part of the profile is coarse fragments.

UTICA SERIES

The Utica series consists of excessively drained, dark-colored, very gravelly Regosols that formed on the high benches and terraces. The identifying characteristics of the Utica soils are a thin, dark-colored A1 horizon and a limy layer of pebbles, cobblestones, and loam in which the pebbles and cobblestones are coated with lime.

In the Utica soils large quantities of pebbles and cobblestones are below the A1 horizon at a depth of 10 inches or less, but in the Judith soils the depth to very gravelly material is greater.

Typical profile of Utica gravelly loam (1,330 feet north and 920 feet west of NE. corner of SE¼ sec. 23, T. 13 N., R. 13 E.; 50 feet west of bench edge):

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) when moist; weak, coarse and fine, granular structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; abundant roots; strongly calcareous; pH 8.4; clear boundary.

Cca—6 to 19 inches, light yellowish-brown (10YR 6/4) coarse and fine gravelly sandy loam, light yellowish brown and brown (10YR 6/4 and 4/3) when moist; massive; strongly calcareous; pH 8.6; some cementation of sand and small pebbles to the underside of cobblestones; prominent stalactites on underside of pebbles; all pebbles are coated with lime; clear boundary.

IIIC—19 to 72 inches, loose, incoherent sand and gravel; 70 percent of horizon, by volume, is coarse pebbles and cobblestones and 30 percent is finer material; very gravelly and stratified.

Gravelly loam and stony loam are the most common soil types of the Utica series in the survey area. Cobblestones and stones make up 50 to 80 percent of the coarse substratum below the A1 horizon. The materials between the pebbles, cobblestones, and stones range from limy sand to limy sandy clay loam and are in irregular strata. The lime crusts around and on the underside of the coarse fragments are thickest just below the A1 horizon and are less thick with increasing depth.

WINIFRED SERIES

The Winifred series consists of well-drained Chestnut soils that developed in clay loam alluvium that is underlain by clay that was transported from local areas or developed in place from shale. The profile of Winifred soils is identified by (1) a thin, dark A1 horizon 2 to 4 inches thick; (2) a B2 horizon that has strong and moderate, prismatic and blocky structure; (3) pronounced segregations of lime; and (4) shale that is deep or moderately deep in the profile.

In the Winifred soils prismatic structure extends deeper than in the Savage soils, the segregated lime is more prominent and is in the form of concretions or splotches rather than films, and more shale is in the profile.

Typical profile of Winifred clay loam (500 feet east of center of sec. 27, T. 16 N., R. 12 E., 50 feet south of center of road; in native pasture):

A1—0 to 3 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; moderate, medium and fine, granular structure; soft when dry, friable when moist, sticky and plastic when wet; pH 7.5; clear, irregular boundary.

B21—3 to 14 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; compound structure of moderate, coarse and medium prisms to moderate, very fine, subangular blocks; very hard when dry, friable when moist, sticky and plastic when wet; tongues from the A1 horizon extend to a depth of about 12 inches; pH 7.6; abrupt, very irregular and broken boundary that includes a discontinuous B3ca horizon at a depth of 6 to 12 inches; B3ca horizon is gray heavy clay loam that has prismatic structure and lime casts on underside of pebbles.

B22bca—14 to 29 inches, gray (5Y 5/1) heavy clay loam containing many, very fine fragments of shale; dark olive gray (5Y 3/2) when moist; compound structure of strong, coarse prisms to strong, coarse to fine, angular blocks; extremely hard when dry, friable when moist, sticky and plastic when wet; distinct clay films mixed with many, medium and large, white, soft nodules of pure calcium carbonate; moderately calcareous between lime nodules; prominent lime casts on underside of pebbles; pH 7.6; gradual boundary.

IIB23ca—29 to 37 inches, dark-gray (5Y 4/1) clay containing many fine fragments of shale; black (5Y 2/1) when moist; few, medium, prominent, dark-olive mottles and many, large, prominent, white mottles of pure calcium carbonate; moderate, very coarse, prismatic structure; extremely hard when dry, friable when moist, sticky and plastic when wet; distinct, continuous clay films on prisms; lime mottles inside prisms; prominent lime casts on underside of pebbles; slightly calcareous between lime nodules; pH 7.6; gradual boundary.

IIC—37 to 48 inches, dark-gray (5Y 4/1) clay containing an abundance of fine, flat fragments of shale; massive; hard when dry, friable when moist, sticky and plastic when wet; slightly calcareous; common threads of segregated lime; pH 7.8.

IIR—48 to 64 inches, dark-gray (5Y 4/1) fragmented, horizontally bedded clay shale, black (5Y 2/1 and 2/2) when moist; very weakly calcareous.

Clay loam and cobbly clay loam are mapped in the survey area. The A1 horizon is generally noncalcareous, but in cultivated areas the surface layer is generally calcareous. Because the depth to the clay residuum ranges from 15 to 50 inches, the upper part of the B2 horizon is generally heavy clay loam and the lower part is clay. The prisms commonly extend to the shale, which is at a depth of 30 to 50 inches.

WOODHURST SERIES

The Woodhurst series consists of well-drained, stony, noncalcareous Chernozems. These soils developed in loamy material that weathered in place from igneous rock in the foothills and in mountainous areas. The profile of Woodhurst soils is identified by (1) a thick, very dark colored A1 horizon; (2) a moderately dark colored B2 horizon that has more clay than the A1 horizon and fine,

subangular blocky or granular structure; (3) a high proportion of stones throughout the solum; and (4) bedrock moderately shallow or shallow in the profile.

The Woodhurst soils have a thicker, darker A1 horizon than the Blaine soils and lack the carbonate horizons of those soils. They are more stony than the Teton soils and developed from igneous rock rather than sandstone.

Typical profile of Woodhurst stony loam (1,500 feet north and 450 feet east of the center of sec. 26, T. 14 N., R. 11 E.; in native range):

A1—0 to 12 inches, very dark grayish-brown (10YR 3/2) stony loam in which stones make up 30 to 40 percent of horizon, by volume; nearly black (10YR 2/1) when moist; single grain to weak, fine, crumb structure; soft when dry, friable when moist; abundant roots; noncalcareous; pH 7.6; clear boundary.

B2—12 to 20 inches, dark grayish-brown (10YR 4/2) stony clay loam in which stones make up 60 percent of horizon, by volume; moderate, fine, blocky structure to very fine, granular structure; peds contain weathered igneous rocks that are easily crushed by hand; soft when dry, friable when moist; continuous, distinct clay films on vertical faces of peds and on weathered rock; patches of clay on horizontal faces of peds; abundant roots; noncalcareous; pH 7.8; clear boundary.

BR—20 to 26 inches, brown (10YR 4/3) stony clay loam in which stones make up 60 to 70 percent of horizon, by volume; dark-brown (10YR 3/3) when moist; moderate, medium and fine, blocky structure; slightly hard when dry, friable when moist; distinct, continuous clay films on all ped faces; noncalcareous; pH 8.3; clear, wavy boundary.

R—26 inches +, light-colored, hard bedrock of quartz monzinite porphyry; weathered rock has been stained darker by organic matter.

Stony loam is the only type of the Woodhurst series mapped separately in the survey area, but Woodhurst soils are mapped in complexes with Alder, Loberg, Spring Creek, Teton, and Cheadle soils. The A1 horizon ranges from 10 to 15 inches in thickness. The B2 horizon contains about 5 percent more clay than the A1 horizon. Stones make up 30 to 60 percent of the soil volume. Depth to hard rock ranges from 15 to 30 inches.

Mechanical and Chemical Analyses

The data on physical properties of soils in table 13, and those on chemical properties in table 14, were obtained by mechanical and chemical analyses of selected soils in the Judith Basin Area. The profiles of the soils analyzed are described in the section "Formation and Classification of Soils." The information in tables 13 and 14 is useful in classifying soils and in determining how they formed. It can be used in estimating water-holding capacity, fertility, tilth, susceptibility to wind erosion, and other properties that affect soil management. The data on reaction, electrical conductivity, and the percentage of exchangeable sodium can be used in evaluating the possibility of reclaiming and managing saline or alkali soils.

Field and laboratory methods

All samples used to obtain the data in tables 13 and 14 were collected from carefully selected pits. The samples are representative of the soil material that is made up of particles less than ¾ inch in diameter. During the sampling, estimates were made of the fraction of the sample consisting of particles larger than ¾ inch. If necessary, the sample was sieved after it was dried, and rock fragments larger than ¾ inch in diameter were discarded. Then the material made up of particles less than ¾ inch was rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. The fraction that consists of particles between 2 millimeters and ¾ inch in diameter is recorded in the table as the percentage of particles larger than 2 millimeters. This percentage is calculated as percent of the total weight of particles smaller than ¾ inch in diameter.

The percentage of fractions that consists of particles larger than ¾ inch, and the percentage of those between 2 millimeters and ¾ inch, is somewhat arbitrary. But the fractions at these sizes do contain relatively unaltered rock fragments larger than 2 millimeters in diameter and do not contain slakable clods of earthy material.

Unless otherwise noted, all laboratory analyses were made on oven-dried material that passed the 2-millimeter sieve, and the results were converted to an oven-dry basis. In table 14, values for extractable sodium and potassium are the amounts extracted by the ammonium acetate method, minus the amounts that are soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in tables 13 and 14. Determinations of clay were made by the pipette method (*6*, *7*, *9*). The reaction of a 1:1 and 1:5 water suspension were measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*10*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples that were treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of absorbed ammonia (*10*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*12*). Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

General Nature of the Survey Area[8]

Additional information about the Judith Basin Area is given in this section. It is useful mainly to persons not familiar with the area. It describes relief, history, natural resources, transportation, agriculture, climate, and other subjects of general interest.

Relief, Drainage, and Geology

For this report 897,980 acres were surveyed. The area lies entirely within Judith Basin County but excludes that part of the Lewis and Clark National Forest in the Little Belt Mountains. The survey area consists of the foothills of the Little Belt Mountains, part of the Highwood Mountains and their foothills, and an unglaciated part of the northern Great Plains in the eastern and northeastern parts of the county.

[8] By EDWARD C. MORGAN, work unit conservationist, Soil Conservation Service.

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TABLE 13.—*Physical properties*

[Analysis made at Soil Survey Laboratory, Soil Conservation Service,

Soil	Horizon	Depth	Particle size distribution				
			Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 0.10 mm.)	Very fine sand (0.10–0.05 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Alder clay loam:							
Sample No. S58 Mont–23–4–(1–5).	A1	0–4	3.0	1.9	1.0	3.8	8.0
Laboratory No. 8387–8391.	B1	4–10	2.8	2.1	.9	3.0	7.6
	B21	10–14	1.2	1.2	.6	.9	8.5
	B22	14–21	2.0	1.3	.5	1.2	6.6
	B3	21–27	1.2	1.0	.4	.5	4.5
Alder clay loam:							
Sample No. S58 Mont–23–5–(1–5).	A1	0–5	4.9	3.6	2.5	3.0	16.5
Laboratory No. 8392–8396.	B1	5–13	4.2	4.1	2.5	3.9	15.6
	B21	13–17	2.4	3.0	2.0	2.7	18.7
	B22	17–22	2.6	2.6	1.4	2.7	25.0
	B3	22–27	.8	.8	.6	1.0	11.6
Danvers clay loam:							
Sample No. S58 Mont–23–6–(1–7).	Ap	0–4	1.2	2.1	2.8	7.7	11.7
Laboratory No. 8397–8403.	B2	4–8	.6	1.7	2.8	7.8	8.7
	B3	8–12	2.7	2.9	4.6	11.5	9.7
	C1ca	12–19	1.6	2.4	3.9	10.9	9.9
	C2ca	19–27	.8	1.6	2.8	8.9	9.8
	D1	27–31	19.6	13.8	9.3	14.1	7.2
	D2	31–45	18.0	22.4	19.5	17.4	5.0
Danvers clay loam:							
Sample No. S58 Mont–23–7–(1–7).	Ap	0–4	1.0	2.7	3.4	9.1	10.5
Laboratory No. 8404–8410.	B2	4–10	.9	1.8	3.0	4.3	13.6
	B3	10–14	1.8	2.5	4.2	5.1	15.0
	C1ca	14–23	[2] 1.3	[2] 2.2	[2] 3.3	[2] 4.4	[2] 14.0
	C2	23–34	[2] 1.0	[2] 1.5	[2] 2.4	[2] 5.7	[2] 12.6
	D1	34–39	[2] 7.3	[2] 4.9	[2] 5.9	[2] 14.6	[2] 14.1
	D2	39–50	[2] 13.1	[2] 6.8	[2] 8.7	[2] 28.2	[2] 12.6
Teton loam:							
Sample No. S58 Mont–23–1–(1–7).	A11	0–5	2.0	2.4	3.8	9.7	14.4
Laboratory No. 8367–8372.	A12	5–9	1.5	2.4	4.2	14.3	10.9
	B1	9–15	2.9	3.4	5.8	15.9	8.4
	B21	15–22	1.6	3.1	5.1	14.1	11.3
	B22	22–31	.9	2.7	5.8	19.2	11.3
	B3	31–47	1.1	3.3	7.7	20.8	12.0
Terrad clay:							
Sample No. S58 Mont–23–2–(1–7).	A1	0–3½	2.6	1.1	1.1	[2] 4.5	[2] 11.0
Laboratory No. 8373–8379.	B21	3½–11	.6	.6	.8	[2] 1.8	[2] 10.1
	B22	11–23	.5	.3	.4	[2] 3.9	[2] 7.8
	B23ca	23–37	.3	.2	.2	[2].6	[2] 7.9
	B3ca	37–45	<.1	.2	.3	[2].9	[2] 4.3
	CD [3]	45–55	<.1	.1	.2	[2] 2.2	[2] 10.1
	D [3]	55–65	<.1	.1	.1	[2] 2.3	[2] 12.0
Terrad clay:							
Sample No. S58 Mont–23–3–(1–7).	A1	0–4	.9	2.2	3.6	[2] 7.3	[2] 8.0
Laboratory No. 8380–8386.	B21	4–9	.2	1.3	3.2	[2] 7.0	[2] 7.4
	B22	9–16	.4	1.3	2.2	[2] 4.4	[2] 4.7
	B23ca	16–23	.3	1.1	2.0	[2] 4.1	[2] 4.5
	B31ca	23–36	.4	.9	1.8	[2] 3.9	[2] 3.9
	B32	36–49	.2	.7	.8	[2] 1.8	[2] 1.7
	CD	49–59	<.1	.2	.2	[2].7	[2].7

[1] Trace.
[2] Common, smooth, brown to black concretions, probably iron-manganese.

for selected soils

Lincoln, Nebr. Absence of value indicates determination was not made]

Particle size distribution—Continued					Textural class	Moisture held at tensions of—		
Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	International silt (0.2–0.02 mm.)	Fine silt (0.02–0.002 mm.)	Coarse particles (more than 2 mm.)		1/10 atmosphere	1/3 atmosphere	15 atmospheres
Percent	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
52. 8	29. 5	33. 6	29. 7	(1)	Silty clay loam	53. 6	36. 3	17. 3
52. 4	31. 2	33. 7	28. 3	(1)	Silty clay loam	39. 3	29. 3	13. 9
54. 3	33. 3	33. 1	29. 9	3. 2	Silty clay loam	34. 6	26. 4	13. 3
46. 2	42. 2	24. 8	28. 6	5. 8	Silty clay	35. 2	29. 5	17. 8
52. 3	40. 1	19. 6	37. 3	14. 0	Silty clay	37. 8	30. 7	18. 7
44. 8	24. 7	37. 4	24. 1	(1)	Loam	49. 2	33. 6	15. 8
43. 5	26. 2	39. 1	21. 5	(1)	Loam	31. 4	24. 5	12. 2
40. 6	30. 6	41. 0	19. 0	10. 6	Clay loam	30. 1	21. 9	11. 9
27. 6	38. 1	40. 3	13. 1	20. 9	Clay loam	30. 5	23. 9	14. 4
19. 7	65. 5	20. 3	11. 2	6. 3	Clay	48. 5	38. 1	25. 2
42. 6	31. 9	37. 9	21. 0	1. 9	Clay loam	33. 4	24. 9	12. 2
38. 6	39. 8	32. 5	19. 4	1. 4	Clay loam	35. 4	26. 6	15. 0
32. 5	36. 1	30. 6	18. 1	14. 3	Clay loam	31. 8	23. 8	13. 7
32. 5	38. 8	29. 9	19. 0	2. 2	Clay loam	32. 5	25. 8	13. 0
35. 5	40. 6	30. 2	20. 4	14. 8	Clay	34. 7	26. 2	12. 7
17. 2	18. 8	21. 4	9. 8	72. 8	Coarse sandy loam	21. 8	15. 6	8. 7
10. 6	7. 1	16. 3	6. 2	73. 8	Loamy coarse sand	8. 3	7. 3	4. 2
40. 0	33. 3	35. 1	20. 5	(1)	Clay loam	35. 3	27. 1	12. 9
38. 2	38. 2	33. 1	19. 3	(1)	Clay loam	35. 0	27. 2	14. 7
32. 8	38. 6	29. 3	18. 6	11. 3	Clay loam	32. 0	24. 4	13. 2
30. 5	44. 3	26. 8	17. 9	7. 6	Clay	33. 4	25. 9	13. 4
31. 8	45. 0	28. 1	18. 7	8. 3	Clay	35. 7	25. 6	13. 0
21. 2	32. 0	29. 3	12. 6	60. 3	Sandy clay loam	28. 9	19. 3	10. 2
12. 7	17. 9	32. 4	6. 9	70. 2	Sandy loam	16. 3	11. 0	6. 3
36. 1	31. 6	35. 5	18. 6	5. 6	Clay loam	56. 3	39. 3	23. 0
36. 2	30. 5	35. 8	18. 9	15. 6	Clay loam	43. 5	30. 0	14. 8
34. 2	29. 4	33. 6	17. 1	23. 9	Clay loam	33. 6	24. 4	12. 1
32. 6	32. 2	33. 6	16. 8	17. 5	Clay loam	33. 3	22. 8	12. 7
29. 8	30. 3	35. 6	15. 8	17. 3	Clay loam	31. 6	21. 8	12. 1
23. 8	31. 3	25. 7	19. 5	30. 9	Clay loam	31. 3	22. 1	12. 4
41. 2	38. 5	31. 1	23. 5	(1)	Silty clay loam	43. 2	31. 2	15. 9
33. 3	52. 8	24. 1	19. 4	1. 6	Clay	37. 7	29. 4	17. 3
34. 0	53. 1	24. 2	20. 5	(1)	Clay	38. 6	30. 3	16. 9
43. 7	47. 1	23. 9	27. 8		Silty clay	34. 4	26. 0	14. 6
45. 2	49. 1	14. 1	35. 9		Silty clay	32. 8	25. 1	14. 3
45. 3	42. 1	21. 7	35. 4		Silty clay	34. 4	27. 4	16. 1
50. 6	34. 9	27. 4	37. 0		Silty clay loam	44. 1	37. 4	21. 0
36. 2	41. 8	25. 2	23. 4		Clay	39. 8	31. 3	17. 0
31. 4	49. 5	23. 9	19. 1		Clay	37. 6	29. 7	17. 1
28. 7	58. 3	15. 8	20. 2		Clay	39. 7	31. 0	18. 6
30. 3	57. 7	16. 0	21. 2		Clay	37. 7	30. 1	17. 6
31. 8	57. 3	14. 5	23. 5		Clay	35. 6	27. 6	16. 2
23. 0	71. 8	6. 4	19. 4		Clay	33. 5	26. 9	16. 5
24. 7	73. 5	2. 9	22. 9		Clay	30. 7	24. 2	14. 8

[3] Determination is questionable because of inability to get dispersion of sample.

TABLE 14.—*Chemical*

[Analysis made at Soil Survey Laboratory, Soil Conservation

Soil	Depth	Horizon	pH (1:1)	Organic matter			Free iron (Fe_2O_3)	Electrical conductivity (EC x 10^3 millimhos per cm. at 25° C.)	$CaCO_3$ equivalent	Gypsum	Cation exchange capacity (NH_4Ac)
				Organic carbon	Nitrogen	C/N ratio					
	Inches			*Percent*	*Percent*		*Percent*		*Percent*	*Meq./100 gm.*	*Meq./100 gm.*
Alder clay loam:											
Sample No. S58 Mont-23-4-(1-5).	0–4	A1	[1] 6.1	6.36	0.476	13.4	0.8				36.2
Laboratory No. 8387-8391.	4–10	B1	6.1	3.18	.256	12.4	.9				32.5
	10–14	B21	6.3	1.37	.126	10.9	.8				30.2
	14–21	B22	6.4	.77	.084	9	.8				47.2
	21–27	B3	6.7	.49	.055	9	.4		<1		59.6
Alder clay loam:											
Sample No. S58 Mont-23-5-(1-5).	0–5	A1	[1] 6.1	6.87	.496	13.8	1.3				31.4
Laboratory No. 8392-8396.	5–13	B1	5.6	3.36	.246	13.6	1.5				25.6
	13–17	B21	5.8	1.17	.102	11.5	1.6				24.3
	17–22	B22	5.8	.72	.066	11	1.9				33.0
	22–27	B3	5.8	.67	.049	14	1.3				65.3
Danvers clay loam:											
Sample No. S58 Mont-23-6-(1-7).	0–4	Ap	6.3	1.93	.171	11.3	1.5				21.6
Laboratory No. 8397-8403.	4–8	B2	7.3	1.10	.132	8.3	1.5		2		27.3
	8–12	B3	8.0	1.33	.135	9.8	1.3		18		19.0
	12–19	C1ca	8.2	.94	.098	10	1.2		24		16.4
	19–27	C2ca	8.3	.53	.066		1.1		26		16.4
	27–31	D1	8.4	.30			1.2		29		8.5
	31–45	D2	8.7	.07			1.7		24		5.2
Danvers clay loam:											
Sample No. S58 Mont-23-7-(1-7).	0–4	Ap	6.4	1.68	.164	10.2	1.6				21.7
Laboratory No. 8404-8410.	4–10	B2	7.2	1.27	.128	9.9	1.5		<1		25.7
	10–14	B3	8.1	1.08	.129	8.4	1.2		19		18.3
	14–23	C1ca	8.3	.72	.071	10	1.0		27		16.6
	23–34	C2	8.5	.24	.029	8	.9		30		15.5
	34–39	D1	8.7	.13			1.1		25		11.7
	39–50	D2	8.7	.08			1.2		18		8.9
Teton loam:											
Sample No. S58 Mont-23-1-(1-7).	0–5	A11	[1] 6.3	10.04	.711	14.1	2.1				41.2
Laboratory No. 8367-8372.	5–9	A12	5.7	4.93	.365	13.5	2.4				30.4
	9–15	B1	5.8	2.18	.197	11.1	2.4				24.4
	15–22	B21	6.0	.89	.079	11	2.6				28.8
	22–31	B22	6.2	.64	.055	12	2.6				29.6
	31–47	B3	6.6	.34			2.5		<1		29.9
Terrad clay:											
Sample No. S58 Mont-23-2-(1-7).	0–3½	A1	6.1	5.46	.367	14.9	2.4	.4			27.9
Laboratory No. 8373-8379.	3½–11	B21	6.2	1.56	.153	10.2	2.7	.4			30.0
	11–23	B22	7.3	.81	.081	10	3.2	.8	1		29.6
	23–37	B23ca	8.1	.24	.051		3.1	2.1	7	<1	25.1
	37–45	B3ca	8.1	.17			3.6	2.9	4	<1	23.1
	45–55	CD	7.9	.13			.9	5.5	2	<1	36.2
	55–65	D	8.0	.31			.2	2.6	2	<1	53.2
Terrad clay:											
Sample No. S58 Mont-23-3-(1-7).	0–4	A1	6.1	3.88	.325	11.9	2.8	.5			25.8
Laboratory No. 8380-8386.	4–9	B21	6.1	1.96	.166	11.8	3.1	.4			26.0
	9–16	B22	7.2	1.00	.086	11.6	3.4	.7	1		26.9
	16–23	B23ca	7.8	.73	.079	9	3.4	.7	3		25.3
	23–36	B31ca	8.1	.46	.054	8	3.4	1.4	7		23.0
	36–49	B32	7.8	.21			3.5	4.0	3	3	21.0
	49–59	CD	7.9	.12			2.5	3.6	1	1	22.1

[1] pH by 1:5 instead of 1:1 water suspension.

properties of selected soils

Service, Lincoln, Nebr. Dashes indicate values not determined]

Extractable cations							Base saturation		Ca/Mg ratio	Exchangeable sodium	Saturation extract soluble		Moisture at saturation
Ca	Mg	H	Na	K	Sum	Sum-H	(NH_4Ac exchange)	On Sum+H			Na	K	
Meq./100 gm.	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Percent*	*Percent*		*Percent*	*Meq./100 gm.*	*Meq./100 gm.*	*Percent*
23.2	4.3	12.3	<0.1	3.6	43.4	31.1	86	72	5.4	----	----	----	----
21.2	4.6	8.8	.1	2.9	37.6	28.8	89	76	4.6	----	----	----	----
19.8	4.5	4.6	.1	2.5	31.5	26.9	89	85	4.4	----	----	----	----
33.1	10.1	1.9	.3	3.9	49.3	47.4	100	96	3.3	----	----	----	----
----	13.1	2.9	.6	5.4	----	65.4	----	----	----	----	----	----	----
17.7	3.6	16.4	<.1	2.4	40.1	23.7	75	59	4.9	----	----	----	----
14.8	3.6	13.0	<.1	1.1	32.5	19.5	76	60	4.1	----	----	----	----
15.3	5.4	6.5	.1	.5	27.8	21.3	88	77	2.8	----	----	----	----
22.2	8.4	6.1	.1	.4	37.2	31.1	94	84	2.6	----	----	----	----
48.7	16.3	6.8	.4	.4	72.6	65.8	100	91	3.0	----	----	----	----
15.6	2.8	6.0	<.1	1.4	25.8	19.8	92	77	5.6	----	----	----	----
----	----	----	<.1	.8	----	----	----	----	----	----	----	----	----
----	----	----	.1	.4	----	----	----	----	----	----	----	----	----
----	----	----	.1	.3	----	----	----	----	----	----	----	----	----
----	----	----	.1	.4	----	----	----	----	----	----	----	----	----
----	----	----	.1	.2	----	----	----	----	----	----	----	----	----
----	----	----	.1	.1	----	----	----	----	----	----	----	----	----
16.2	3.5	4.6	<.1	1.4	25.7	21.1	97	82	4.6	----	----	----	----
----	4.4	2.8	<.1	.8	----	30.4	----	----	----	----	----	----	----
----	----	----	<.1	.4	----	----	----	----	----	----	----	----	----
----	----	----	<.1	.4	----	----	----	----	----	----	----	----	----
----	----	----	.1	.4	----	----	----	----	----	----	----	----	----
----	----	----	.1	.2	----	----	----	----	----	----	----	----	----
----	----	----	.1	.2	----	----	----	----	----	----	----	----	----
28.5	6.0	15.8	<.1	2.1	52.4	36.6	89	70	4.8	----	----	----	----
16.7	3.4	16.0	<.1	.8	36.9	20.9	69	57	4.9	----	----	----	----
14.5	4.0	11.2	<.1	.7	30.4	19.2	79	63	3.6	----	----	----	----
18.7	7.1	7.1	<.1	.3	33.2	26.1	91	79	2.6	----	----	----	----
20.1	8.4	5.6	.1	.2	34.4	28.8	97	91	2.4	----	----	----	----
----	8.1	3.8	.1	.2	----	30.2	----	----	----	----	----	----	----
17.1	4.5	9.4	<.1	2.1	----	----	----	----	----	<1	.5	.8	85.8
17.8	7.7	7.6	.1	2.0	----	----	----	----	----	<1	.5	.4	67.1
----	----	----	.4	1.2	----	----	----	----	----	1	1.8	.2	65.6
----	----	----	1.3	.6	----	----	----	----	----	3	7.5	.1	61.5
----	----	----	1.6	.4	----	----	----	----	----	4	11.1	.2	61.3
----	----	----	2.6	.6	----	----	----	----	----	4	17.2	.2	71.0
----	----	----	3.5	.8	----	----	----	----	----	5	12.4	.3	75.5
17.4	4.5	8.0	<.1	2.0	----	----	----	----	----	<1	.4	.8	74.1
16.4	5.7	5.6	.1	1.5	----	----	----	----	----	<1	.5	.4	63.0
----	----	----	.2	1.2	----	----	----	----	----	1	.5	.2	73.9
----	----	----	.4	.9	----	----	----	----	----	1	1.7	.1	73.0
----	----	----	.8	.6	----	----	----	----	----	2	3.8	.1	74.5
----	----	----	1.1	.6	----	----	----	----	----	2	7.6	.3	87.9
----	----	----	1.0	.5	----	----	----	----	----	2	7.5	.4	74.2

The Highwood Mountains, some parts 7,000 feet above sea level, are in the northwestern part of the survey area and consist of volcanic material and uplifted sedimentary rocks. The foothills of the Little Belt Mountains are in the southwestern part of the survey area. They consist of uplifted sedimentary rocks with several stocks and other igneous intrusions that have caused small domes and exposures of igneous rock.

The Judith Basin Area lies in the Missouri River drainage system. Drainage to the river is provided by the Judith River, Arrow Creek, Otter Creek, and their tributaries.

The Judith River rises in the Little Belt Mountains, flows northeastward, and leaves the survey area at the east boundary of the county. Arrow Creek rises on the east side of the divide that is between the two mountain ranges and forms the west boundary of the basin. Arrow Creek flows toward the east and northeast. It leaves the survey area at the north boundary of the county. Otter Creek and its tributaries rise on the west side of this divide and flow northwestward out of the survey area.

These streams are perennial, but they have many tributaries that are generally intermittent. The tributaries are fed by seasonal springs and surface runoff. Many other streams originate in Judith Basin County, but they flow into larger streams outside of the survey area.

Below the foothills of the Highwood Mountains and the Little Belt Mountains are remnants of broad alluvial plains, or benches, that at one time extended across most of the plains section. Coarse fragments in the benches originated in the mountains. Geologists have grouped the benches into five levels according to differences in elevation. The material of the youngest and lowest benches was deposited by the present streams. The elevation of the lowest terraces in the northeastern part of the survey area drops to about 3,700 feet.

Much material has been removed from the benches by the many dissecting streams and by natural geologic erosion. The underlying bedrock is exposed in places along the sides of the streams. North of Arrow Creek and in other places nearly all of the bench material has been removed, and a large area of Colorado shale is exposed. Approximately 60 percent of the basin is covered by benches or terraces that lie at various levels. In this report those at the lower levels are called terraces, and those at the higher levels are called benches.

Formations ranging in geologic age from Mississippian to Tertiary are exposed in the survey area. These formations dip to the north and northeast more than does the surface of the land. Consequently, the older formations are exposed in the Little Belt Mountains. The more commonly exposed formations are the Madison, the Kootenai, and the Colorado. The massive limestone cliffs in the mountains are of the Madison formation. Exposed in the foothills is the Kootenai formation, which is the source of red soil materials and soils. Dense shale and bentonite of the Colorado formation is exposed on the plains.

A few dikes of dark-colored igneous rock occur in the survey area. They appear as narrow ridges above the surrounding landscape and extend in a northeast-southwest direction, except near the Highwood Mountains where they extend in a northwest-southeast direction.

History and Settlement

At least a century before the Lewis and Clark expedition, the Judith Basin Area was a summer resort and a favorite hunting ground for the Blackfeet, Nez Perces, Gros Ventres, Piegan, and Crow Indians. It was the scene of many fights between rival Indian tribes that came to hunt buffalo and other wild game.

The first known white man to enter what is now Judith Basin County was Father DeSmet, a Catholic priest. With the Blackfeet Indians, he entered the Judith Basin in 1846 near Judith Gap. He proceeded north across the basin to Arrow Creek and then to Square Butte and Fort Benton.

Mining camps were the first settlements in the area. Silver and lead were discovered in the Little Belt Mountains in the 1870's and 1880's. Trading posts for the mining centers were established—Utica in 1881, Kibby in 1883, and Stanford in 1884.

In this era raising livestock was as important as mining. Cattle owners moved large herds in from the valleys of western Montana to graze the abundant grassland. Charles Russell, the cowboy artist, painted many of his works in this locale. His picture, "The Last of the 5000." was painted in the vicinity of Utica.

After the Great Falls-Billings branch of the Great Northern Railway was completed in 1908, large ranch holdings were subdivided into 160- and 320-acre tracts. Homesteaders came in and pioneered dryland farming and ranching. After the arrival of the homesteaders, Hobson, Stanford, Geyser, and Raynesford, which were stage centers, moved to the Great Northern Railway line and thrived as trading centers. Many of the early miners and stockmen were of English and Scotch descent. The homesteaders were mostly native Americans who came from the farming and industrial centers of the north-central and central parts of the United States. Many of the people that live in Geyser are of Finnish descent. Their ancestors were among the early miners who worked the coal, lead, and silver mines in the Little Belt Mountains and at Belt, in Cascade County, which is west of the survey area.

The county of Judith Basin was organized in 1920 from parts of Fergus and Cascade Counties, because at that time the basin had population and resources adequate to support a new county government. Stanford, the county seat and largest town, is centrally located.

Natural Resources

The most valuable natural resources in Judith Basin Area are soil, water, minerals, and timber. According to the 1959 Census of Agriculture, 70 percent of the county is grassland. An early newspaper described the highland as "covered with fine bunchgrass upon which hay can be mown nearly every season." Although much of the grassland has deteriorated because of overgrazing, it still supports large numbers of livestock and can be made more productive by good management. Wheat and other small grain are important on the cropland.

Water.—Except for the northeastern part, the survey area is well supplied with surface water. Springs and

seeps abound in the foothills. The springs are more scattered in the lower parts of the watershed, but they generally produce more water than those in the foothills. The water is hard, but it is normally excellent for drinking.

The area from Geyser eastward to Hobson and Kolin is artesian. The watershed starts on the Little Belt Mountains and slopes northeastward. Many wells, 200 to 2,000 feet deep, supply water that is suitable for livestock and household use. This artesian water is softer than the water in other parts of the survey area, but in some places the content of iron and sulfur is high.

Water for irrigation comes mainly from the Judith River and from private storage systems. Practically all irrigated areas are used for hay. Ackley Lake, south of Hobson, is used for irrigation and has a live storage capacity of 5,815 acre-feet. It receives its water when runoff that comes from springs is diverted away from the Judith River and into the lake. This irrigation project is managed by the Montana State Water Conservation Board.

The main streams in the Judith Basin Area cannot be depended on to supply irrigation water throughout the growing season. In the mountains the Judith River and Wolf Creek are perennial and carry a great deal of water when snow melts during April, May, and June. At lower levels, however, the water in these streams disappears in summer and early in fall, for it is taken in by the gravelly streambeds.

Minerals.—Minerals played an important part in the early development of Judith County. Gold was discovered in Yogo Gulch above Utica in 1865, though no great quantities were taken. Large quantities of high grade ore of silver, lead, and zinc were mined near Barker early in the 1880's and were transported by ox teams to Fort Benton, in Chouteau County, on the Missouri River to be taken to distant smelters. When silver was demonetized in 1892, the mines were shut down. Nearly 6 million dollars worth of gold, silver, copper, lead, and zinc were mined between 1920 and 1948, but today only a small amount of these metals is mined.

Mining iron ore was recently important in the Running Wolf District, 14 miles southwest of Stanford. The open pit method was used. The ore, ranging from 60 to 65 percent pure iron, was trucked to Stanford and shipped by rail to Duluth, Minn., for eastern steel mills. The first year of production was in 1957 and amounted to 12,000 tons of ore. The mines shut down in 1958 because a surplus of ore had been stockpiled at the eastern mills. Mining was resumed in 1959, and more than 37,000 tons were mined, but operations were stopped again because of high freight rates and increased mining costs.

In the early days sapphires were mined in Judith Basin County. Production from 1884, when they were discovered in Yogo Gulch, to 1929 was estimated at about 16 million carats. Fifteen percent of this amount was of gem quality and had an estimated value of 20 to 30 million dollars.

Coal of good quality underlies a part of the county along the foothills. Coal mining was important after the railroads were built in 1908. The Great Northern Railway owned mines and operated them until 1922, but they were closed down because coal-burning engines were no longer used and coal could not compete with other fuel. The extensive deposits of bentonite along Arrow Creek northeast of Geyser and north of Stanford have not been developed. These deposits are of good quality and can be mined after only a little overburden is removed.

Timber.—Most woodland in Judith Basin County is outside the survey area. Within the survey area, there are about 16 square miles of national forest land in the Highwood Mountains and small tracts of private forest in the northeastern front of the Little Belt Mountains. Little use has been made of these timber resources.

Transportation and Recreational Facilities

The survey area has a good system of roads. It is crossed by U.S. Highway No. 87, a two-lane highway between Great Falls, in Cascade County, and Lewistown, in Fergus County. One asphalt road runs between Hobson and Utica, and another between Stanford and Fort Benton in Chouteau County. The county roads are gravelled and have been raised in recent years so that they are free from drifting snow. Each way between Lewistown and Great Falls passenger buses provide the towns along U.S. Highway No. 87 with service. The Great Northern Railway and various trucklines provide daily freight and express service. A landing field adjacent to Stanford accommodates light planes.

Judith Basin Area provides good hunting and fishing. Elk in the Little Belt and Highwood Mountains attract hunters from out of the State as well as within. Mule deer range the mountains and the rough coulees in the foothills and along the main streams. White-tailed deer occupy bushy areas, mainly on the bottom land of the Judith River. Among the game birds in the survey area are Chinese pheasant, Hungarian pheasant, sharptailed duck, ruff grouse, and blue grouse. The Montana Fish and Game Department stocks trout in the Judith River, Running Wolf Creek, and the larger artificial lakes. Many farmers and ranchers own spring-fed trout ponds that can be fished all year. Commercial hatcheries in Montana and Washington supply trout fry for private stocking. Scenery and restful picnic spots abound in the Lewis and Clark National Forest. The Forest Service maintains two main campgrounds, one on the South Fork of the Judith River and one on Dry Wolf Creek. Although Ackley Lake is small, it provides boating and water skiing.

Agricultural History

The population of Judith Basin County was at its peak of about 7,000 when the county was organized in 1920. At that time the farms were much smaller than they are today. Farm implements were drawn by horses. Since 1920 the county, like most rural counties in Montana, changed greatly. Tractors have replaced horses, and combines and other machines do much of the work that was formerly done by men and horses. This mechanization and the industrial development elsewhere have encouraged an increase in the size of farms, as shown in table 15. It has also encouraged people to leave the county, as indicated by the decrease in population from 1930 to 1960. In 1930 there were 5,238 people in the county; in 1940, 3,655; in 1950, 3,204; and in 1960, 3,085.

TABLE 15.—*Number and size of farms in stated years*

Year	Number	Size of farms
		Acres
1930	776	1,021
1940	599	1,377
1950	490	1,756
1959	418	2,050

About 260,000 acres in the survey area are cropland. The 1959 Census of Agriculture shows that the county had an income of approximately $3,971,000 from crops and $3,447,000 from livestock. Winter wheat is the most important crop, and barley is next. Most of the barley is shipped to other parts of Montana for fattening cattle. Recently, however, ranchers in the survey area have gone into the feeding business; they market in Great Falls, Lewistown, and Billings.

The kinds and number of livestock on farms and ranches in the county are shown for stated years in table 16. Table 17 lists the acreage of principal crops in 1949 and 1959.

TABLE 16.—*Kinds and number of livestock in stated years*

Livestock	1930	1940	1950	1959
	Number	*Number*	*Number*	*Number*
Cattle and calves	26,609	[1] 20,952	46,221	50,718
Sheep and lambs	64,948	[2] 63,818	29,573	29,584
Hogs and pigs	2,491	[3] 937	1,071	2,652
Horses and mules	6,476	[1] 3,261	1,701	999
Chickens	[1] 31,647	[3] 23,373	[3] 18,488	[3] 12,996

[1] More than 3 months old.
[2] More than 6 months old.
[3] More than 4 months old.

TABLE 17.—*Acreage of principal crops in stated years*

Crop	1949	1959
	Acres	*Acres*
Winter wheat threshed or combined	51,629	64,657
Spring wheat threshed or combined	50,841	8,755
Barley threshed or combined	17,272	32,194
Oats threshed or combined	3,132	4,435
Hay crops, total	44,128	44,429

To aid in producing crops and forage, a branch of the Montana Agricultural Experiment Station was established in 1907 in the central part of the county. This station serves the central part of Montana (fig. 19). Here experiments are carried out to acquire information that will help farmers and ranchers. Among the activities at this station are—

1. Evaluating varieties of small grain and oil crops, and selecting varieties on the basis of production, quality, and resistance to disease; for example, selecting varieties of wheat that are good for milling and baking.
2. Testing and evaluating new crops.

***Figure 19.*—A branch of the Montana Agricultural Experiment Station is centrally located in the grain-producing area of Judith Basin Area. The station is on Danvers and Judith clay loams. (Photograph courtesy of Calder's Exclusive Aerial Murals, Lewistown, Mont.)**

3. Conducting research in crop rotation, tillage methods, fertilization, and other practices of soil management.
4. Experimenting in the control of weeds in grains, forage, and shelterbelts, including the evaluation of new chemicals.
5. Conducting research in hay and pasture production, including tests of varieties, research in seed production, and the evaluation of selections and accessions.
6. Testing varieties of vegetables, shrubs, and trees.

Climate [9]

The two mountain ranges in the western part of the survey area and the hills and valleys in other parts cause the climate of the area to vary greatly within short distances. The variations are in temperature, amount of precipitation, speed of wind, and rate of evaporation. These components of climate and the hazards of storms are discussed in this section.

TEMPERATURE

The climate of the survey area is continental. Moderating influences of the Pacific Ocean are cut off by the continental divide. Extremes of temperature of −57° and 108° F. have been recorded in the survey area, but these extremes are not representative of usual conditions. About once in 5 years, extremes of as high as 100° and as low as −35° do occur. Cold spells usually last for only a few days and then give way to warmer weather that comes with foehn, or chinook, winds. Foehn winds are warm, dry winds that blow down the sides of mountains. They are usually from a southwest to a west direction, and only a few days after they start, temperature rises to near or somewhat above freezing. Summers are generally warm, but the weather is seldom oppressively hot. Stanford is one of the warmer areas of the survery area, but on an average of only about 10 days in a year is the temperature 90° or higher. Because the relative humidity is almost always low when temperature is highest, the weather is seldom uncomfortable. Rarely do hot spells last long

[9] By R.A. DIGHTMAN, State climatologist, U.S. Weather Bureau.

enough to damage crops or retard their growth. Most summer days are only moderately warm, and summer nights are almost always pleasantly cool. The average minimum temperature is around 50°.

Average temperatures for four weather stations that are in or near the survey area are listed in table 18. Kings Hill, though outside the area, is included, for its temperatures are representative of those in the Little Belt Mountains. At Stanford the temperature record is long enough for estimates to be made of the average number of days between the last temperatures of 32°, 28°, and 24° in spring and the first of these temperatures in fall. Because there are only 104 days between the last temperature of 32° in spring and the first temperature of 32° in fall, the growing season for tender plants is relatively short. But hardy varieties of small grain have time enough to mature at Stanford because there are 130 days between the last temperature of 28° in spring and the first temperature of 28° in fall, and there are 154 days between the last temperature of 24° in spring and the first temperature of 24° in fall.

It is estimated that 1 year out of 5 at Stanford the last minimum temperature of 32° or lower will not occur by June 15, and that in 1 year out of 5 the first minimum temperature of 32° or lower will occur by August 31. In 1 year out of 5, therefore, there will be a very short freeze-free period of only 97 days. On the other hand, in 1 year out of 5 there will be a freeze-free period of as much as 135 days, because in 1 year out of 5 the last freeze of 32° or lower will occur as early as May 16 in spring, and in 1 out of 5 years the first freeze in fall will occur as late as October 1. Table 19 lists dates for given probabilities and minimum temperatures of at least 32°, 28°, and 24° at Stanford.

TABLE 18.—*Average temperatures and snowfall at four stations for stated periods*

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
MEAN MAXIMUM TEMPERATURE IN °F.														
Kings Hill	1938–52	23.2	27.4	32.4	43.7	51.4	58.4	70.6	69.8	58.9	48.4	34.1	27.4	45.5
Moccasin	1931–52	32.5	34.3	39.4	54.2	63.8	69.2	82.1	80.1	69.1	59.1	44.4	37.2	55.5
Stanford	1931–52	34.3	35.9	41.1	55.7	64.9	70.2	82.5	80.2	70.1	60.0	46.2	38.8	56.7
Utica	1894–1927	33.7	35.8	41.6	53.7	61.6	71.0	79.5	79.0	68.0	57.5	45.0	36.2	55.2
MEAN MINIMUM TEMPERATURE IN °F.														
Kings Hill	1938–52	5.4	8.4	11.6	21.7	28.7	34.6	42.1	40.9	33.7	26.0	15.9	10.5	23.3
Moccasin	1931–52	8.9	10.5	17.7	29.3	38.4	45.2	51.3	49.4	40.9	32.7	21.0	14.3	30.0
Stanford	1931–52	9.7	10.4	17.5	28.4	37.6	44.4	50.3	48.5	40.8	32.3	21.2	14.4	29.6
Utica	1894–1927	12.0	12.5	18.1	29.3	36.7	44.2	49.6	48.8	40.6	32.1	23.2	16.1	30.3
MEAN TEMPERATURE IN °F.														
Kings Hill	1938–52	14.3	17.9	22.0	32.7	40.1	46.5	56.4	55.3	46.3	37.2	25.0	18.9	34.4
Moccasin	1931–52	20.8	22.4	28.6	41.8	51.2	57.2	66.7	64.7	55.1	46.0	32.7	25.8	42.8
Stanford	1931–52	22.0	23.2	29.3	42.0	51.2	57.3	66.4	64.4	55.5	46.1	33.7	26.6	43.1
Utica	1894–1927	22.8	24.2	29.8	41.5	49.2	57.6	64.6	63.9	54.3	44.8	34.1	26.2	42.8
HIGHEST TEMPERATURE IN °F.														
Kings Hill	1938–52	50	55	60	69	75	83	86	90	81	74	57	51	90
Moccasin	1931–52	72	74	74	87	91	101	102	101	95	87	75	72	102
Stanford	1931–52	68	69	73	87	92	102	102	102	95	88	77	70	102
Utica	1894–1927	62	70	74	85	91	108	104	100	94	90	79	64	108
LOWEST TEMPERATURE IN °F.														
Kings Hill	1938–52	−41	−36	−31	−11	5	11	27	27	12	−3	−17	−34	−41
Moccasin	1931–52	−40	−48	−29	−18	8	29	34	31	11	−5	−23	−31	−48
Stanford	1931–52	−35	−44	−27	−19	9	24	34	32	15	−6	−17	−30	−44
Utica	1894–1927	−46	−57	−25	−8	10	24	32	30	1	−19	−27	−42	−57
MEAN SNOWFALL IN INCHES														
Kings Hill	1938–52	33.8	39.4	32.7	21.6	12.5	8.5	0.5	0.1	7.3	15.4	35.0	42.5	249.3
Stanford	1931–52	7.1	7.0	9.0	5.0	1.6	.5	.1	(1)	.8	3.8	6.6	7.3	48.8
Utica	1894–1927	8.1	6.0	9.0	5.4	2.9	.4	0	0	1.5	7.3	8.6	7.7	56.9

TABLE 19.—*Probability of last freezing temperature in spring and first in fall*

[Based on records kept at Stanford]

Probability	Dates for given probability and temperature		
	At least 32°F.	At least 28°F.	At least 24°F.
Spring:			
3 years in 4, later than	May 26	May 9	Apr. 25
1 year in 2, later than	June 4	May 18	May 4
1 year in 5, later than	June 15	May 29	May 15
1 year in 20, later than	June 25	June 9	May 25
Fall:			
3 years in 4, earlier than	Sept. 24	Oct. 2	Oct. 12
1 year in 2, earlier than	Sept. 16	Sept. 24	Oct. 4
1 year in 5, earlier than	Sept. 6	Sept. 14	Sept. 24
1 year in 20, earlier than	Aug. 28	Sept. 5	Sept. 15

PRECIPITATION

The amount of precipitation and its distribution through the year are important to farming. The seasonal and annual precipitation in the survey area can be fairly closely correlated with crop production. A study of the precipitation records at Stanford, Moccasin, Hopson, and Utica shows that most of the precipitation in a year normally falls during the period from April to September, or during the growing season. The longer records at Stanford and Moccasin show that, on the average, 75 percent of the annual precipitation falls during this period. An annual total precipitation of about 15 inches would seem extremely low for crop production, but 11 out of the 15 inches falls when the crops need moisture most. Normally, May and June are the wettest months, and they are also the months that crops grow most rapidly and, therefore, need the most moisture.

In some years annual precipitation is less than normal, and its distribution is not the best. Fewer than 10 years in the 50 years of record at Moccasin could be called dry, and even in those years there tended to be adequate moisture in May and June. The record shows the same tendency at Stanford. Probably in only 1 or 2 out of 10 years is crop production seriously decreased because moisture is insufficient, and even in these years crop loss is not total. The records show that very seldom is there as little as 10 inches of annual precipitation at any recording station in the Judith Basin Area. In the higher elevations, annual precipitation probably is never as little as 10 inches. Table 20 gives probabilities of stated amounts of precipitation for each month of the year at Moccasin, and table 21 gives the same information for Stanford.

Little information is available on precipitation frequency and intensity. Snows are seldom heavy, and except on the mountains, snowfall is less than 50 inches a year. In the higher southwestern mountains, snow may fall any month of the year, but in other places in the survey area, snow does not fall in June, July, or August. Rains are sometimes heavy in May and June, and occasionally in July and August. Records at Stanford and Moccasin show that only once or twice a year are there daily amounts of rain of more than 1 inch. Except during thunderstorms in July and August, the rain falls so slowly that a maximum amount infiltrates the soil. Table 22 shows the maximum amount of rainfall in Judith Basin Area that is likely to fall during storms of varied duration and how frequently such storms can be expected.

SPEED OF THE WIND

In this survey area the chinook winds sometimes have a speed of 60 miles per hour. Occasionally during a storm, the wind has a speed of 80 miles per hour and soil blowing is a problem, but such a wind occurs less than once a year. The strongest winds during the growing season are westerly, except for the gusty ones that accompany windstorms and blow from any direction. In the plains section of the survey area, the average speed of the wind is high, not because extremes are high but because there is always some wind.

TABLE 20.—*Probability of listed amounts of monthly precipitation at Moccasin*

[Based on records of period from 1928 through 1958]

Month	1 year in 10 will have:		2 years in 10 will have:		3 years in 10 will have:		4 years in 10 will have:	
	Less than—	More than—	Less than—	More than—	Less than—	More than—	Less than—	More than—
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	0.1	0.9	0.2	0.8	0.3	0.6	0.3	0.5
February	.1	.7	.1	.6	.3	.5	.3	.5
March	.2	1.3	.3	.9	.4	.9	.4	.7
April	.3	2.1	.4	1.1	.5	1.1	.6	.9
May	.5	3.1	1.0	3.1	1.5	2.6	1.7	2.3
June	1.4	5.8	1.9	4.3	2.4	4.1	2.7	3.6
July	.4	2.7	.9	2.1	1.0	1.6	1.1	1.4
August	.3	2.8	.5	2.3	.7	2.2	.9	1.9
September	.2	2.6	.4	2.0	.6	1.8	.8	1.3
October	.2	1.8	.2	1.4	.3	1.1	.4	.7
November	.1	1.0	.2	.8	.2	.7	.4	.6
December	.1	1.1	.2	.8	.2	.7	.3	.6
Annual	9.8	18.1	10.1	16.3	12.0	15.6	12.7	15.1

TABLE 21.—*Probability of listed amounts of monthly precipitation at Stanford*

[Based on records of period from 1928 through 1958]

Month	1 year in 10 will have:		2 years in 10 will have:		3 years in 10 will have:		4 years in 10 will have:	
	Less than—	More than—	Less than—	More than—	Less than—	More than—	Less than—	More than—
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	0.1	0.8	0.3	0.8	0.3	0.6	0.4	0.5
February	.1	.9	.3	.8	.4	.7	.4	.7
March	.3	1.2	.4	1.1	.5	1.0	.6	.9
April	.4	1.9	.4	1.3	.5	1.1	.8	1.0
May	.7	4.2	1.1	3.4	1.3	2.9	1.6	2.6
June	1.3	5.4	1.7	4.7	2.4	4.2	2.9	3.7
July	.4	4.0	.5	2.8	.9	2.3	1.1	1.7
August	.3	3.4	.5	2.4	.7	2.2	.8	1.8
September	.2	2.9	.4	2.1	.5	2.0	1.0	1.7
October	.1	1.9	.2	1.3	.3	1.2	.4	.9
November	.1	1.2	.2	1.0	.3	.8	.4	.7
December	.1	1.3	.2	1.0	.2	.9	.4	.7
Annual	11.0	19.6	11.3	18.3	12.7	16.7	13.4	16.5

TABLE 22.—*Estimated maximum amounts of rainfall in Judith Basin Area for stated periods of duration and the frequency that these amounts occur*

[Based on data from U.S. Weather Bureau Technical Paper No. 40 (*15*)]

Duration	Frequency: Once in—				
	2 years	5 years	10 years	25 years	50 years
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
30 minutes	0.5	0.7	0.9	1.0	1.2
1 hour	.6	.9	1.1	1.3	1.5
3 hours	.9	1.2	1.5	1.8	2.0
6 hours	1.1	1.5	1.8	2.0	2.3
12 hours	1.3	1.7	2.1	2.5	2.8
24 hours	1.5	2.0	2.5	2.9	3.3

EVAPORATION

Evaporation has been measured at the Moccasin Experiment Station for 6 months of each year from 1909 through 1955 by the sunken pan method. This method was initiated by the Bureau of Plant Industry. The class A method of the U.S. Weather Bureau was used from 1956 through 1958. The values obtained from the sunken pan method were multiplied by 1.45 to convert them into class A approximations. For the two periods combined, evaporation in average inches of water for each month is as follows: April, 5.69; May, 7.48; June, 7.09; July, 11.07; August, 10.68; September, 7.06. The average total for the 6 months is 49.07 inches. A fair approximation of the water loss through evaporation from reservoirs and ponds can be obtained by multiplying these figures by 0.7.

HAILSTORMS, BLIZZARDS, AND THUNDERSTORMS

Hailstorms damage crops in the Judith Basin Area much more than other storms. Scarcely a year passes without hail causing crop losses in some part of the survey area, but seldom is there damage on more than a small part of the farm acreage in any one year. The most troublesome hailstorms occur between the time that the small grain starts to head and the time of harvest. At other times the moisture brought by most hailstorms is valuable enough to more than offset any damage they cause.

Blizzards occur in winter, and high winds blow in spring and summer. The blizzards are not so hazardous as they were 50 years ago, when the facilities for transportation, communication, and power were primitive compared with those of today. But at least once or twice during most winters dangerous blizzards do occur. When winds are about 40 miles an hour, and the temperature is 10 below zero, the unwary or unprepared can be seriously troubled by blowing and drifting snow. Winds can damage windows, roofs, television antennas, and other things, but winds strong enough to cause such damage occur less than once a year and probably only once in about 5 years.

Lightning causes some damage during heavy thunderstorms, which in summer may also bring hail. Tornadoes are practically unknown in this part of Montana.

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Glossary

Alkaline soil. Generally, a soil that is alkaline throughout most or all of the parts occupied by plant roots, although the term is commonly applied to only a specific layer or horizon of a soil. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Bench. In this report the term bench refers to high, broad alluvial plains. They differ from the lower lying, narrow, younger alluvial plains, which are called terraces.

Calcareous soils. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that contains thin, flat fragments of sandstone, limestone, or schist, as much as 6 inches in length along the longer axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above or below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Cobblestones. Rounded or partly rounded fragments of rock, 3 to 10 inches in diameter.

Complex, soil. A mapping unit composed of two or more soils that are mingled in such an intricate pattern or in such small individual areas that they cannot be shown separately on a published soil map.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; soil does not hold together in a mass.

Friable. When moist, soil crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, soil readily deformed by moderate pressure but can be pressed into a lump; forms a wire when rolled between thumb and forefinger.

Sticky. When wet, soil adheres to other material; tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard. When dry, soil moderately resistant to pressure; difficult to break between thumb and forefinger.

Soft. When dry, soil breaks into powder or individual grains under very slight pressure.

Cemented. Hard and brittle; little affected by moistening.

Delineation, soil. An area within a soil boundary on a map.

Dryland. All land that is not irrigated.

Fine sandy loam. Soil material that contains 30 percent or more fine sand and less than 30 percent very fine sand or between 15 and 30 percent very coarse, coarse, and medium sand.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes and that differs in one or more ways from adjacent horizons in the same profile. These are the major, or master, soil horizons:

A horizon.—The mineral horizon at the surface. It contains an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both.

B horizon.—The horizon in which clay minerals or other material have accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes.

C horizon.—The unconsolidated material immediately under the true soil. In chemical, physical, and mineral composition it is presumed to be similar to the material from which at least part of the overlying solum has developed, unless the C designation is preceded by a Roman numeral.

R horizon.—Rock underlying the C horizon, or the B horizon if no C horizon is present.

Roman numerals are prefixed to the master horizon or layer designations (A, B, C, R) to indicate lithologic discontinuities either within or below the solum. The first, or uppermost, material is not numbered, for the Roman numeral I is understood; the second, or contrasting, material is numbered II, and others are numbered III, IV, and so on, consecutively downward. Thus for example, a sequence from the surface downward might be A2, B1, IIB2, IIB3, IIC1, IIIC2.

Following are the small-letter symbols that may be a part of a horizon designation (Cca) and the meaning of these symbols:

b—buried soil.
ca—accumulation of calcium.
g—strong gleying.
p—plow layer.
sa—accumulation of salts more soluble than calcium sulfate.
t—illuvial clay.

Inclusion. An area of soil that has been included in the mapping unit of a soil of a different kind.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loamy sand. Soil material that contains 25 percent or more very coarse, coarse, and medium sand, and less than 50 percent fine or very fine sand.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many;* size—*fine, medium*, and *coarse;* and contrast—*faint, distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue.

Parent material (soil). Weathered rock or partly weathered soil material from which a soil has formed; the C horizon.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid*, and *very rapid*.

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects management.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. (See also Horizon.)

Reaction. The degree of acidity or alkalinity of the soil expressed either in pH values or in words, as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4–7.8
Very strongly acid	4.5–5.0	Moderately alkaline	7.9–8.4
Strongly acid	5.1–5.5	Strongly alkaline	8.5–9.0
Medium acid	5.6–6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1–6.5		
Neutral	6.6–7.3		

Residuum. Unconsolidated, partly weathered mineral material that accumulates over disintegrating solid rock. Residuum is not a soil but is frequently the material in which a soil has formed.

Runoff. The removal of water by flow over the surface of the soil. The amount and rapidity of surface runoff are affected by the texture, structure, and porosity of the surface layer, by the vegetative covering, by the prevailing climate, and by the slope. The rate of surface runoff is expressed as follows: *ponded, very slow, slow, medium, rapid*, and *very rapid*.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Sandy loam. Soil material that contains either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 percent and 52 percent sand.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the profile.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Silt loam. Soil material that contains 50 percent or more silt and 12 to 27 percent clay or 50 to 80 percent silt and less than 12 percent clay.

Silty clay. Soil material that contains 40 percent or more clay and 40 percent or more silt.

Silty clay loam. Soil material that contains 27 percent to 40 percent clay and less than 20 percent sand.

Stones. Rock fragments greater than 10 inches in diameter if rounded, and greater than 15 inches along the longer axis if flat.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *angular blocky* (prisms with sharp corners), *subangular blocky* (prisms with mostly rounded corners), *granular* (granules relatively nonporous), *crumb* (similar to granular but very porous). *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon of a soil with a distinct profile; commonly, that part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil; the C or R horizon.

Surface soil. Technically, the A horizon; commonly, the plow layer.

Terrace. In this report the term terrace refers to the lower lying, narrow, younger alluvial plains. They differ from the higher lying, older, broad alluvial plains, which are called benches.

Texture, soil. The relative amounts of the various size classes of soil particles, such as sand, silt, and clay.

Tilth, soil. The physical properties of the soil that affect the ease or difficulty with which it can be cultivated or its suitability for crops; implies the presence or absence of favorable soil structure.

Topography. The elevations or inequalities of the land surface, the slope gradient, and the pattern of these.

Type, soil. A subdivision of a soil series based on the texture of the surface layer.

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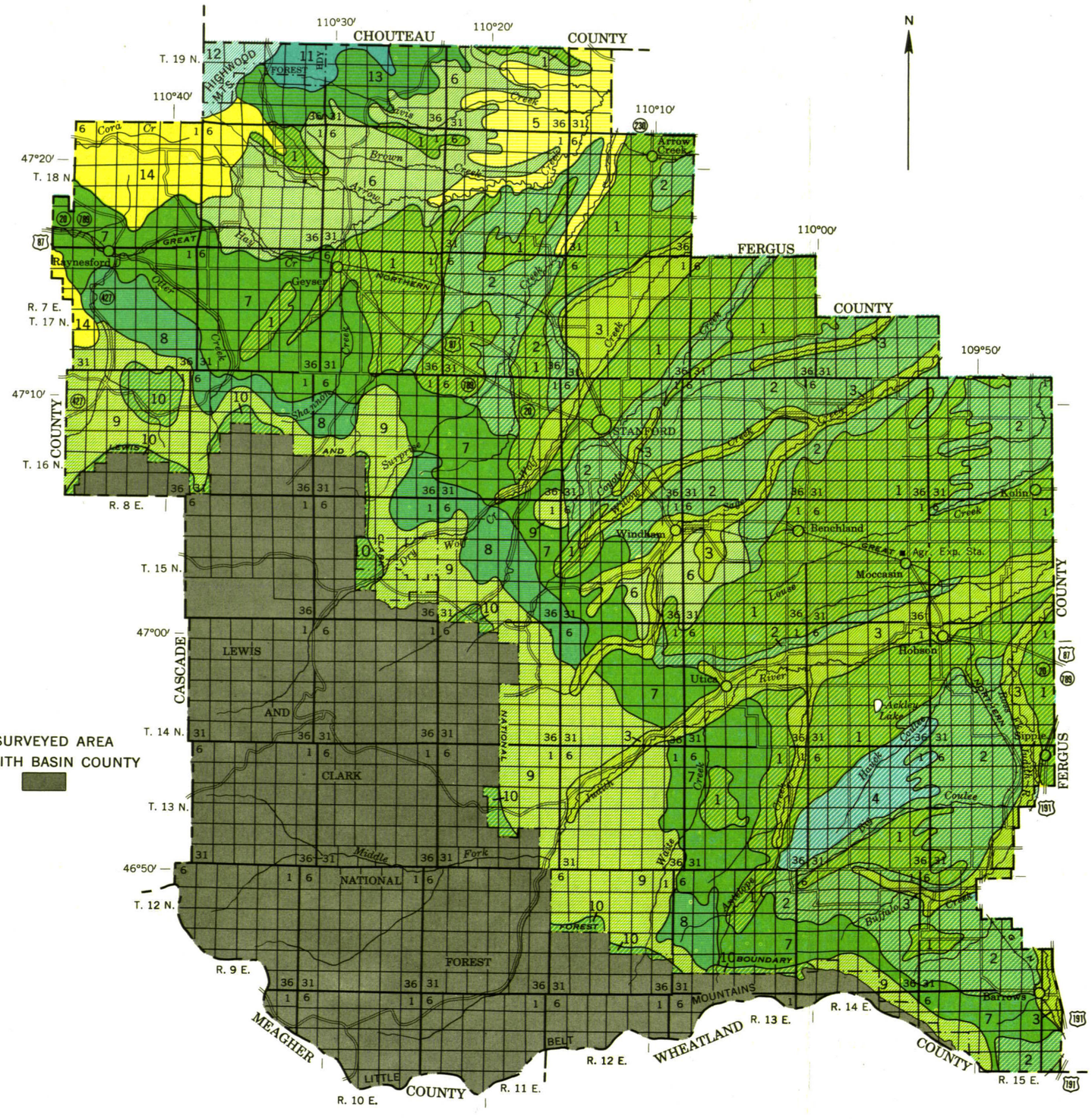
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
U. S. FOREST SERVICE
MONTANA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

JUDITH BASIN AREA, MONTANA

Scale 1:380 160

1 0 1 2 3 4 5 6 7 Miles



UNSURVEYED AREA
OF JUDITH BASIN COUNTY

SOIL ASSOCIATIONS

1 — Danvers-Judith association: Deep and moderately deep, loamy soils over very gravelly material on nearly level and gently sloping high benches

2 — Winifred-Utica association: Deep and moderately deep clay loams over shale on rolling uplands and thin, very gravelly soils on steep edges of benches

3 — Savage-Straw-Gallatin association: Deep, well-drained to imperfectly drained, loamy soils on nearly level and gently sloping bottoms and low terraces

4 — Judith-Ashuelot association: Gravelly loams moderately deep over very gravelly material or shallow over a lime-cemented hardpan; on nearly level and gently sloping high benches

5 — Lismas-Shale land association: Shallow clays and outcrops of shale on steep, rough, broken topography

6 — Absarokee-Maginnis association: Dark-colored clay loams that are moderately deep and channery clay loams that are shallow over hard shale and sandstone; on sloping to steep uplands

7 — Cheadle-Darret-Fergus association: Dark-colored, shallow, loamy soils over sandstone and reddish, moderately deep, loamy soils over shale; mainly on moderate to steep slopes in the uplands

8 — Teton-Cheadle association: Dark-colored loams deep and shallow over sandstone; on gentle to steep slopes in the uplands

9 — Skaggs-Duncom association: Nearly black, moderately deep and shallow, loamy soils over limestone; on moderate to steep slopes in the uplands

10 — Hughesville-Duncom association: Moderately deep, loamy, forested soils and grass-covered soils shallow over limestone; on mountain slopes

11 — Cowood association: Shallow to moderately deep, forested soils on steep and very steep mountain slopes and intermingled with barren igneous rock in some places

12 — Sapphire-Woodhurst-Teton association: Forested, loamy soils moderately deep over sandstone and grass-covered, loamy soils moderately deep over igneous rock and sandstones; on steep, smooth slopes of the Highwood Mountains

13 — Bridger-Woodhurst association: Deep stony and nonstony loams on gentle to moderately steep slopes and moderately deep stony loams over igneous rock; on steep and moderately steep slopes of the foothills

14 — Alder-Maginnis association: Very dark or dark, moderately deep clay loams and shallow or very shallow channery clay loams over hard shale and sandstone; on sloping to steep uplands

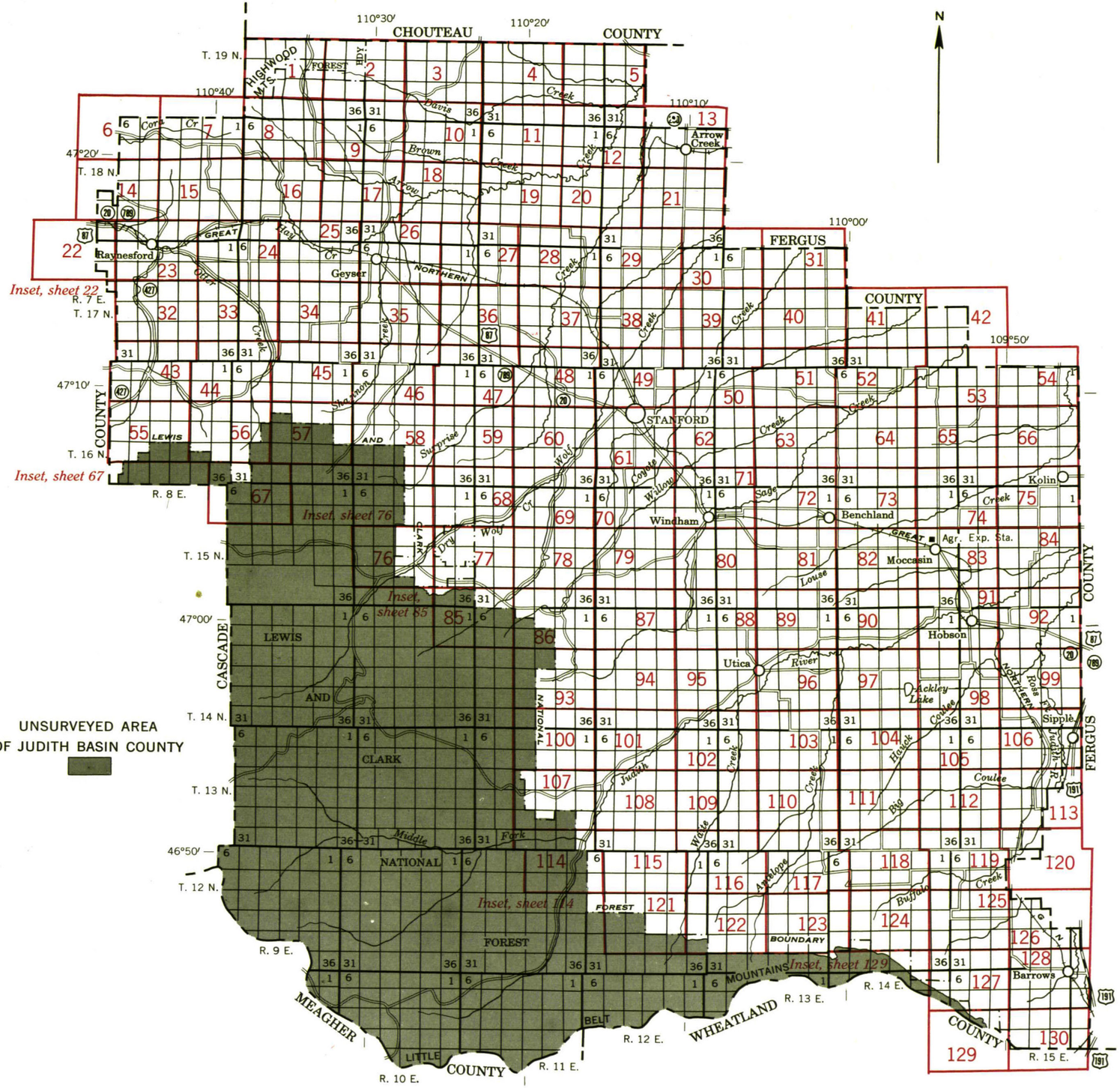
August 1965

INDEX TO MAP SHEETS

JUDITH BASIN AREA, MONTANA

Scale 1: 380 160

1 0 1 2 3 4 5 6 7 Miles



GUIDE TO MAPPING UNITS

[Table 1, beginning on p. 10, gives the acreage and proportionate extent of the soils. Predicted yields are given for dryland in table 2, beginning on p. 63, and for irrigated crops in table 3, beginning on p. 70. The three woodland suitability groups in the survey are discussed in the subsection "Use of Soils as Woodland and in Windbreaks," beginning on p. 77. For information about engineering, see the subsection "Engineering Uses of Soils," beginning on p. 85]

Map symbol	Soil name	Page	Dryland capability unit Symbol	Page	Irrigated capability unit Symbol	Page	Range site Name	Page	Windbreak suitability group Number	Page
Aa	Absarokee clay loam, 2 to 8 percent slopes	12	IIIe-2	54	None	--	Silty, 15 to 19 inches precipitation	72	5	83
Ab	Absarokee clay loam, 8 to 15 percent slopes	12	IVe-2	56	None	--	Silty, 15 to 19 inches precipitation	72	5	83
Ac	Absarokee silty clay, 2 to 8 percent slopes	12	IIIe-3	54	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Ad	Absarokee-Cheadle channery loams, 2 to 8 percent slopes	12	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Absarokee part	--	IIIe-2	54	None	--	----------	--	5	83
	Cheadle part	--	IVe-6	57	None	--	----------	--	9	84
Af	Absarokee-Cheadle channery loams, 8 to 15 percent slopes, eroded	12	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Absarokee part	--	IVe-2	56	None	--	----------	--	5	83
	Cheadle part	--	VIe-5	59	None	--	----------	--	9	84
Ag	Absarokee-Cheadle stony loams	13								
	Absarokee part	--	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72	None	--
	Cheadle part	--	VIIs-2	61	None	--	Shallow	73	None	--
Ah	Absarokee-Maginnis channery clay loams, 2 to 8 percent slopes	13	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Absarokee part	--	IIIe-2	54	None	--	----------	--	5	83
	Maginnis part	--	IVe-6	57	None	--	----------	--	9	84
Ak	Adel loam, 2 to 8 percent slopes	13	IIIe-1	54	IVe-6	69	Silty, 20 to 24 inches precipitation	75	1	82
Al	Adel loam, 8 to 18 percent slopes	13	IVe-1	56	IVe-6	69	Silty, 20 to 24 inches precipitation	75	2	82
Am	Adel silt loam, terrace	14	IIc-1	54	IIIe-6	68	Silty, 20 to 24 inches precipitation	75	1	82
An	Alder clay loam, 2 to 8 percent slopes	14	IIIe-1	54	None	--	Silty, 20 to 24 inches precipitation	75	5	83

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Ao	Alder clay loam, 8 to 15 percent slopes	14	IVe-1	56	None	--	Silty, 20 to 24 inches precipitation	75	5	83
Ap	Alder stony clay loam, 8 to 15 percent slopes	14	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Ar	Alder-Maginnis channery clay loams, 2 to 8 percent slopes	14	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Alder part	--	IIIe-1	54	None	--	----------	--	5	83
	Maginnis part	--	IVe-6	57	None	--	----------	--	9	84
As	Alder-Maginnis complex, 8 to 35 percent slopes	15								
	Alder part	--	VIe-1	58	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Maginnis part	--	VIe-5	59	None	--	Shallow	73	None	--
At	Arvada-Beckton cobbly clay loams	15								
	Arvada part	--	IVs-1	57	None	--	Dense Clay	74	10	84
	Beckton part	--	IVs-1	57	None	--	Clayey, 15 to 19 inches precipitation	72	10	84
Au	Arvada-Beckton complex, saline	15	VIs-4	60	None	--	Saline Subirrigated	71	None	--
Av	Arvada-Laurel complex	15	-------	--	-------	--	Panspots	74		
	Arvada part	--	IVs-1	57	None	--	----------	--	10	84
	Laurel part	--	VIIs-5	61	None	--	----------	--	None	--
Aw	Arvada-Terrad clays	15	VIe-8	59	None	--	Dense Clay	74	None	--
Ax	Ashuelot gravelly loam	16	VIs-3	60	None	--	Shallow	73	9	84
Ba	Bainville loam	16	IVe-6	57	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Bb	Beckton loam	17	IIIs-1	55	None	--	Silty, 15 to 19 inches precipitation	72	10	84
Bc	Beckton-Arvada clay loams	17								
	Beckton part	--	IIIs-1	55	None	--	Clayey, 15 to 19 inches precipitation	72	10	84
	Arvada part	--	IVs-1	57	None	--	Dense Clay	74	10	84
Bd	Beckton-Danvers clay loams	17	-------	--	-------	--	Clayey, 15 to 19 inches precipitation	72		
	Beckton part	--	IIIs-1	55	None	--	----------	--	10	84
	Danvers part	--	IIc-2	54	None	--	----------	--	3	82

Map symbol	Soil name	Page	Dryland capability unit: Symbol	Page	Irrigated capability unit: Symbol	Page	Range site: Name	Page	Windbreak suitability group: Number	Page
Bf	Beckton-Savage complex-------	17	-------	--	-------	--	Clayey, 15 to 19 inches precipitation	72		
	Beckton part------------	--	IIIs-1	55	None	--	---------------	--	10	84
	Savage part------------	--	IIe-3	53	None	--	---------------	--	7	84
Bg	Blaine-Spring Creek loams, 2 to 8 percent slopes------	18	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Blaine part------------	--	IIIe-4	55	None	--	---------------	--	5	83
	Spring Creek part-------	--	IIIe-4	55	None	--	---------------	--	9	84
Bh	Blaine-Spring Creek stony loams----------	18								
	Blaine part------------	--	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72	None	--
	Spring Creek part-------	--	VIIs-2	61	None	--	Shallow	73	None	--
Bk	Blythe loam, 2 to 4 percent slopes----------	18	IIIe-5	55	None	--	Silty, 20 to 24 inches precipitation	75	7	84
Bm	Blythe loam, 4 to 8 percent slopes----------	19	IIIe-5	55	None	--	Silty, 20 to 24 inches precipitation	75	7	84
Bo	Bowdoin silty clay, low clay variant----------	19	IIIw-1	55	None	--	Subirrigated	71	8	84
Bp	Bridger loam, 2 to 4 percent slopes----------	19	IIc-1	54	IIIe-6	68	Silty, 20 to 24 inches precipitation	75	1	82
Br	Bridger loam, 4 to 15 percent slopes----------	19	IVe-1	56	IVe-6	69	Silty, 20 to 24 inches precipitation	75	2	82
Bs	Bridger stony loam----------	19	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Ca	Castle clay, 4 to 15 percent slopes----------	20	IVe-3	56	None	--	Clayey, 20 to 24 inches precipitation	75	7	84
Cb	Castle clay, 15 to 35 percent slopes----------	20	VIe-2	58	None	--	Clayey, 20 to 24 inches precipitation	75	None	--
Cc	Castle complex----------	20	VIe-2	58	None	--	Clayey, 20 to 24 inches precipitation	75	None	--
Cd	Chama clay loam, 4 to 8 percent slopes----------	20	IIIe-2	54	None	--	Clayey, 15 to 19 inches precipitation	72	5	83

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Cf	Chama-Midway clay loams, 4 to 8 percent slopes	20	-------	--	-------	--	Clayey, 15 to 19 inches precipitation	72		
	Chama part	--	IIIe-2	54	None	--	----------	--	5	83
	Midway part	--	IVe-6	57	None	--	----------	--	9	84
Cg	Chama-Midway clay loams, 8 to 15 percent slopes	21	-------	--	-------	--	Clayey, 15 to 19 inches precipitation	72		
	Chama part	--	IVe-2	56	None	--	----------	--	5	83
	Midway part	--	VIe-6	59	None	--	----------	--	9	84
Ch	Cheadle-Big Timber-Rock outcrop complex	21	-------	--	-------	--	Thin Breaks, 15 to 19 inches precipitation	74		
	Cheadle part	--	VIIs-2	61	None	--	----------	--	None	--
	Big Timber part	--	VIe-6	59	None	--	----------	--	None	--
	Rock outcrop	--	VIIIs-1	62	None	--	----------	--	None	--
Ck	Cheadle channery loam, 2 to 8 percent slopes	21	IVe-6	57	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Cm	Cheadle channery loam, 8 to 15 percent slopes	21	VIe-6	59	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Cn	Cheadle loam, 2 to 8 percent slopes	21	IIIe-4	55	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Co	Cheadle loam, 8 to 15 percent slopes	22	IVe-5	57	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Cp	Cheadle stony loam	22	VIIs-2	61	None	--	Shallow	73	None	--
Cr	Cheadle-Rock outcrop complex	22	-------	--	-------	--	Very Shallow	74		
	Cheadle part	--	VIIs-2	61	None	--	----------	--	None	--
	Rock outcrop	--	VIIIs-1	62	None	--	----------	--	None	--
Cs	Cheadle-Duncom-Rock outcrop complex	22	-------	--	-------	--	Thin Breaks, 20 to 24 inches precipitation	75		
	Cheadle part	--	VIIs-2	61	None	--	----------	--	None	--
	Duncom part	--	VIIs-2	61	None	--	----------	--	None	--
	Rock outcrop	--	VIIIs-1	62	None	--	----------	--	None	--
Ct	Clayey alluvial land	22	VIe-8	59	None	--	Dense Clay	74	None	--
Cu	Cobbly alluvial land	22	VIIs-3	61	None	--	Shallow to Gravel	73	None	--
Cv	Colvin-Lamoure clay loams	23	IIIw-1	55	None	--	Subirrigated	71	8	84
Cw	Cowood stony loam	23	VIIs-6	61	None	--	None	--	None	--
Cx	Cowood-Rock outcrop complex	23								
	Cowood part	--	VIIs-6	61	None	--	None	--	None	--
	Rock outcrop	--	VIIIs-1	62	None	--	None	--	None	--
Da	Danvers clay loam, 0 to 2 percent slopes	24	IIc-2	54	IIc-3	68	Silty, 15 to 19 inches precipitation	72	3	82

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit: Symbol	Page	Irrigated capability unit: Symbol	Page	Range site: Name	Page	Windbreak suitability group: Number	Page
Db	Danvers clay loam, 2 to 4 percent slopes	24	IIe-1	53	IIIe-7	68	Silty, 15 to 19 inches precipitation	72	3	82
Dc	Danvers clay loam, 4 to 8 percent slopes	24	IIIe-2	54	None	--	Silty, 15 to 19 inches precipitation	72	3	82
Dd	Danvers cobbly clay loam, 0 to 4 percent slopes	24	IIe-2	53	IIIe-9	68	Silty, 15 to 19 inches precipitation	72	3	82
Df	Danvers cobbly clay loam, 4 to 8 percent slopes	24	IIIe-2	54	IVe-9	69	Silty, 15 to 19 inches precipitation	72	3	82
Dg	Danvers cobbly clay loam, 8 to 15 percent slopes	24	IVe-2	56	IVe-9	69	Silty, 15 to 19 inches precipitation	72	3	82
Dh	Danvers gravelly clay loam, 0 to 4 percent slopes	24	IIe-2	53	None	--	Silty, 15 to 19 inches precipitation	72	3	82
Dk	Danvers stony clay loam, 2 to 4 percent slopes	24	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72	None	--
Dm	Danvers-Judith clay loams, 0 to 2 percent slopes	25	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Danvers part	--	IIc-2	54	None	--	---	--	3	82
	Judith part	--	IIc-2	54	None	--	---	--	6	83
Dn	Danvers-Judith clay loams, 2 to 4 percent slopes	25	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Danvers part	--	IIe-1	53	None	--	---	--	3	82
	Judith part	--	IIe-1	53	None	--	---	--	6	83
Do	Danvers-Judith clay loams, shale substratum, 0 to 4 percent slopes	25	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Danvers part	--	IIe-1	53	None	--	---	--	3	82
	Judith part	--	IIe-1	53	None	--	---	--	6	83
Dp	Danvers-Judith gravelly clay loams, 0 to 2 percent slopes	25	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Danvers part	--	IIe-2	53	None	--	---	--	3	82
	Judith part	--	IIIs-3	56	None	--	---	--	6	83
Dr	Darret clay loam, 8 to 15 percent slopes	26	IVe-2	56	None	--	Silty, 15 to 19 inches precipitation	72	5	83

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Ds	Darret stony clay loam-------	26	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72	None	--
Dt	Darret-Cheadle complex, 2 to 8 percent slopes----------	26	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Darret part------------	--	IIIe-2	54	None	--	---------------	--	5	83
	Cheadle part-----------	--	IVe-6	57	None	--	---------------	--	9	84
Du	Darret-Cheadle complex, 8 to 35 percent slopes---------	26	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Darret part------------	--	VIe-4	58	None	--	---------------	--	None	--
	Cheadle part-----------	--	VIIs-2	61	None	--	---------------	--	None	--
Dv	Darret-Utica complex--------	26	VIe-6	59	None	--	Thin Silty	73	None	--
Dw	Dimmick clay----------	26	VIw-1	59	None	--	Subirrigated	71	None	--
Dx	Duncom stony loam----------	27	VIIs-2	61	None	--	Shallow	73	None	--
Dy	Duncom-Rock outcrop complex-	27	-------	--	-------	--	Very Shallow	74		
	Duncom part------------	--	VIIs-2	61	None	--	---------------	--	None	--
	Rock outcrop-----------	--	VIIIs-1	62	None	--	---------------	--	None	--
Dz	Duncom-Skaggs-Rock outcrop complex----------	27	-------	--	-------	--	Thin Breaks, 20 to 24 inches precipitation	75		
	Duncom part------------	--	VIIs-2	61	None	--	---------------	--	None	--
	Skaggs part------------	--	VIs-1	60	None	--	---------------	--	None	--
	Rock outcrop-----------	--	VIIIs-1	62	None	--	---------------	--	None	--
Fa	Fargo-Hegne silty clays-----	27	IVw-1	57	None	--	Subirrigated	71	8	84
Fc	Fergus clay loam, 0 to 2 percent slopes----------	28	IIc-2	54	IIc-3	68	Clayey, 15 to 19 inches precipitation	72	3	82
Fd	Fergus clay loam, 2 to 4 percent slopes----------	28	IIe-1	53	IIIe-7	68	Clayey, 15 to 19 inches precipitation	72	3	82
Ff	Fergus clay loam, 4 to 8 percent slopes----------	28	IIIe-2	54	IVe-7	69	Clayey, 15 to 19 inches precipitation	72	3	82
Fh	Fergus clay loam, 8 to 15 percent slopes----------	28	IVe-2	56	IVe-7	69	Clayey, 15 to 19 inches precipitation	72	3	82
Fs	Fergus silty clay loam, shale substratum, 2 to 8 percent slopes----------	28	IIIe-2	54	None	--	Clayey, 15 to 19 inches precipitation	72	5	83
Ga	Gallatin clay loam----------	29	IIw-1	53	None	--	Subirrigated	71	4	83
Gb	Gallatin loam----------	29	IIw-1	53	None	--	Subirrigated	71	4	83
Gc	Gallatin loam, clay substratum----------	29	IIIw-1	55	None	--	Subirrigated	71	8	84
Gd	Gallatin soils, wet---------	29	Vw-1	58	None	--	Wetland	71	None	--
Gr	Gallatin and Raynesford loams----------	29	VIw-1	59	None	--	Subirrigated	71	None	--
Hu	Hughesville-Duncom complex--	30								
	Hughesville part-------	--	VIe-7	59	None	--	None	--	None	--
	Duncom part----------	--	VIIs-2	61	None	--	Shallow	73	None	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Ja	Judith-Ashuelot gravelly loams, 0 to 4 percent slopes	30								
	Judith part	--	IIIs-3	56	None	--	Silty, 15 to 19 inches precipitation	72	6	83
	Ashuelot part	--	VIs-3	60	None	--	Shallow	73	9	84
Jb	Judith clay loam, 0 to 2 percent slopes	30	IIc-2	54	IIc-3	68	Silty, 15 to 19 inches precipitation	72	6	83
Jc	Judith clay loam, 2 to 4 percent slopes	31	IIe-1	53	IIIe-7	68	Silty, 15 to 19 inches precipitation	72	6	83
Jd	Judith clay loam, 4 to 8 percent slopes	31	IIIe-2	54	IVe-7	69	Silty, 15 to 19 inches precipitation	72	6	83
Jf	Judith clay loam, low terrace	31	IIIs-2	55	IIs-1	67	Silty, 15 to 19 inches precipitation	72	6	83
Jh	Judith cobbly clay loam, 0 to 4 percent slopes	31	IIIs-3	56	IIIe-9	68	Silty, 15 to 19 inches precipitation	72	6	83
Jk	Judith cobbly clay loam, low terrace, 0 to 4 percent slopes	31	IIIs-3	56	IIIe-9	68	Silty, 15 to 19 inches precipitation	72	6	83
Jl	Judith gravelly clay loam, 0 to 2 percent slopes	31	IIIs-3	56	IIs-3	67	Silty, 15 to 19 inches precipitation	72	6	83
Jm	Judith gravelly clay loam, 2 to 4 percent slopes	31	IIIs-3	56	IIIe-9	68	Silty, 15 to 19 inches precipitation	72	6	83
Jn	Judith gravelly clay loam, 4 to 8 percent slopes	31	IIIe-4	55	IVe-9	69	Silty, 15 to 19 inches precipitation	72	6	83
Jo	Judith gravelly clay loam, low terrace, 0 to 4 percent slopes	32	IIIs-3	56	IIIe-9	68	Silty, 15 to 19 inches precipitation	72	6	83
Jp	Judith-Danvers gravelly clay loams, 0 to 4 percent slopes	32	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Judith part	--	IIIs-3	56	None	--	----------	--	6	83
	Danvers part	--	IIe-2	53	None	--	----------	--	3	82
Jr	Judith and Raynesford stony loams, 2 to 8 percent slopes	32	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit: Symbol	Page	Irrigated capability unit: Symbol	Page	Range site: Name	Page	Windbreak suitability group: Number	Page
Js	Judith and Raynesford stony loams, 8 to 15 percent slopes	32	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Jt	Judith and Savage soils	32	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Judith part	--	IIIe-2	54	None	--	----------	--	6	83
	Savage part	--	IIIe-2	54	None	--	----------	--	3	82
Ju	Judith-Utica gravelly loams, 4 to 8 percent slopes	32	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Judith part	--	IIIe-4	55	None	--	----------	--	6	83
	Utica part	--	IVe-6	57	None	--	----------	--	9	84
Jv	Judith-Utica gravelly loams, 8 to 15 percent slopes	32	-------	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Judith part	--	IVe-5	57	None	--	----------	--	6	83
	Utica part	--	VIe-6	59	None	--	----------	--	None	--
La	Lismas-Pierre clays	33	-------	--	-------	--	Shallow Clay	73		
	Lismas part	--	VIIs-4	61	None	--	----------	--	None	--
	Pierre part	--	VIe-3	58	None	--	----------	--	None	--
Lc	Lismas-Shale outcrop complex	33	-------	--	-------	--	Shale	75		
	Lismas part	--	VIIs-4	61	None	--	----------	--	None	--
	Shale outcrop	--	VIIIs-1	62	None	--	----------	--	None	--
Lh	Little Horn stony loam	34	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Lo	Loamy alluvial land	34	VIs-4	60	None	--	Saline Subirrigated	71	None	--
Lr	Loberg stony loam	34	VIe-7	59	None	--	None	--	None	--
Ls	Loberg-Sapphire complex	34	VIe-7	59	None	--	None	--	None	--
Ma	Maginnis cobbly clay loam	35	VIe-6	59	None	--	Thin Clayey	73	None	--
Mb	Maginnis-Absarokee channery clay loams	35								
	Maginnis part	--	VIe-5	59	None	--	Shallow	73	None	--
	Absarokee part	--	VIe-4	58	None	--	Silty, 15 to 19 inches precipitation	72	None	--
Mc	Maginnis-Alder channery clay loams	35								
	Maginnis part	--	VIe-5	59	None	--	Shallow	73	None	--
	Alder part	--	VIe-1	58	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Mw	Midway clay loam	36	VIe-6	59	None	--	Thin Clayey	73	None	--
Mx	Midway-Shale outcrop complex	36	-------	--	-------	--	Thin Breaks, 15 to 19 inches precipitation	74		
	Midway part	--	VIe-6	59	None	--	----------	--	None	--
	Shale outcrop	--	VIIIs-1	62	None	--	----------	--	None	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Pc	Pierre clay, 2 to 8 percent slopes	36	IVe-7	57	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Pd	Pierre clay, 8 to 35 percent slopes	36	VIe-3	58	None	--	Clayey, 15 to 19 inches precipitation	72	None	--
Pm	Promise clay, 0 to 2 percent slopes	37	IIe-3	53	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Po	Promise clay, 2 to 8 percent slopes	37	IIIe-3	54	IVe-8	69	Clayey, 15 to 19 inches precipitation	72	7	84
Pp	Promise clay, 8 to 15 percent slopes	37	IVe-4	56	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Pr	Promise cobbly clay	37	IVe-4	56	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Ra	Raynesford and Adel loams, 2 to 4 percent slopes	37	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Raynesford part	--	IIc-1	54	IIIe-6	68	----------	--	6	83
	Adel part	--	IIc-1	54	IIIe-6	68	----------	--	1	82
Rd	Raynesford and Adel loams, 4 to 8 percent slopes	38	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Raynesford part	--	IIIe-1	54	IVe-6	69	----------	--	6	83
	Adel part	--	IIIe-1	54	IVe-6	69	----------	--	1	82
Rf	Raynesford and Adel loams, 8 to 15 percent slopes	38	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Raynesford part	--	IVe-1	56	IVe-6	69	----------	--	6	83
	Adel part	--	IVe-1	56	IVe-6	69	----------	--	2	82
Rn	Raynesford and Adel stony loams, 4 to 15 percent slopes	38	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Ro	Rhoades-Arvada complex	38	IVs-1	57	None	--	Panspots	74	10	84
Sa	Saline land	38	VIs-4	60	None	--	Saline Subirrigated	71	None	--
Sb	Sapphire soils	39	VIe-7	59	None	--	None	--	None	--
Sc	Sapphire-Cheadle complex	39								
	Sapphire part	--	VIe-7	59	None	--	None	--	None	--
	Cheadle part	--	VIIs-2	61	None	--	Shallow	73	None	--
Sd	Savage silty clay, 0 to 2 percent slopes	39	IIe-3	53	IIs-2	67	Clayey, 15 to 19 inches precipitation	72	7	84

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
Se	Savage silty clay, 2 to 4 percent slopes	39	IIe-3	53	IIIe-8	68	Clayey, 15 to 19 inches precipitation	72	7	84
Sf	Savage silty clay, 4 to 8 percent slopes	39	IIIe-3	54	IVe-8	69	Clayey, 15 to 19 inches precipitation	72	7	84
Sg	Savage silty clay loam, 0 to 2 percent slopes	40	IIc-2	54	IIc-3	68	Clayey, 15 to 19 inches precipitation	72	3	82
Sh	Savage silty clay loam, 2 to 4 percent slopes	40	IIe-1	53	IIIe-7	68	Clayey, 15 to 19 inches precipitation	72	3	82
Sk	Savage silty clay loam, 4 to 8 percent slopes	40	IIIe-2	54	IVe-7	69	Clayey, 15 to 19 inches precipitation	72	3	82
Sl	Skaggs loam	40	IVe-5	57	None	--	Silty, 20 to 24 inches precipitation	75	6	83
Sm	Skaggs clay loam, 4 to 8 percent slopes	40	IIIe-1	54	None	--	Silty, 20 to 24 inches precipitation	75	6	83
Sn	Skaggs clay loam, 8 to 15 percent slopes	40	IVe-5	57	None	--	Silty, 20 to 24 inches precipitation	75	6	83
So	Skaggs stony clay loam	41	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Sp	Skaggs-Cheadle complex	41								
	Skaggs part	--	VIe-1	58	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Cheadle part	--	VIIs-2	61	None	--	Shallow	73	None	--
Sr	Skaggs-Duncom stony clay loams	41								
	Skaggs part	--	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Duncom part	--	VIIs-2	61	None	--	Shallow	73	None	--
Ss	Skaggs-Raynesford loams, 8 to 35 percent slopes	41	VIe-1	58	None	--	Silty, 20 to 24 inches precipitation	75	None	--
St	Skaggs-Duncom-Hughesville complex	41								
	Skaggs part	--	VIe-1	58	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Duncom part	--	VIIs-2	61	None	--	Shallow	73	None	--
	Hughesville part	--	VIe-7	59	None	--	None	--	None	--
Su	Slocum loam	42	IIw-1	53	None	--	Subirrigated	71	4	83

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit Symbol	Page	Irrigated capability unit Symbol	Page	Range site Name	Page	Windbreak suitability group Number	Page
Sv	Spring Creek-Blaine stony loams	42								
	Spring Creek part	--	VIIs-2	61	None	--	Shallow	73	None	--
	Blaine part	--	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72	None	--
Sw	Straw clay loam, 0 to 2 percent slopes	42	IIc-2	54	IIc-3	68	Silty, 15 to 19 inches precipitation	72	1	82
Sx	Straw clay loam, 2 to 4 percent slopes	42	IIe-1	53	IIIe-7	68	Silty, 15 to 19 inches precipitation	72	1	82
Sy	Straw clay loam, gravelly substratum	43	IIIs-2	55	IIs-1	67	Silty, 15 to 19 inches precipitation	72	6	83
Ta	Terrad clay, 2 to 8 percent slopes	43	IIIe-3	54	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Tb	Terrad clay, 8 to 35 percent slopes	43	IVe-4	56	None	--	Clayey, 15 to 19 inches precipitation	72	7	84
Tc	Terrad silty clay, 0 to 2 percent slopes	43	IIe-3	53	IIs-2	67	Clayey, 15 to 19 inches precipitation	72	7	84
Td	Teton loam, 2 to 8 percent slopes	44	IIIe-1	54	None	--	Silty, 20 to 24 inches precipitation	75	5	83
Tf	Teton loam, 8 to 15 percent slopes	44	IVe-1	56	None	--	Silty, 20 to 24 inches precipitation	75	5	83
Th	Teton-Adel stony loams	44	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Tk	Teton-Cheadle channery loams, 4 to 15 percent slopes	44	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Teton part	--	IIIe-1	54	None	--	----------	--	5	83
	Cheadle part	--	VIe-5	59	None	--	----------	--	9	84
Tm	Teton-Cheadle stony loams, 4 to 15 percent slopes	44	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Teton part	--	VIs-1	60	None	--	----------	--	None	--
	Cheadle part	--	VIIs-2	61	None	--	----------	--	None	--
Tn	Teton-Cheadle stony loams, 15 to 35 percent slopes	44								
	Teton part	--	VIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Cheadle part	--	VIIs-2	61	None	--	Shallow	73	None	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit		Irrigated capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Symbol	Page	Name	Page	Number	Page
To	Twin Creek loam, 2 to 4 percent slopes	45	IIe-1	53	IIIe-7	68	Silty, 15 to 19 inches precipitation	72	1	82
Tp	Twin Creek loam, 4 to 8 percent slopes	45	IIIe-2	54	IVe-7	69	Silty, 15 to 19 inches precipitation	72	1	82
Tr	Twin Creek loam, 8 to 15 percent slopes	45	IVe-5	57	None	--	Silty, 15 to 19 inches precipitation	72	2	82
Tw	Twin Creek clay loam, 0 to 2 percent slopes	45	IIc-2	54	IIc-3	68	Silty, 15 to 19 inches precipitation	72	1	82
Ua	Utica gravelly loam, 2 to 8 percent slopes	45	IVe-6	57	None	--	Silty, 15 to 19 inches precipitation	72	9	84
Ub	Utica gravelly loam, 8 to 35 percent slopes	46	VIe-6	59	None	--	Thin Silty	73	None	--
Ug	Utica-Judith gravelly loams, sandy substratum	46	-----	--	-------	--	Silty, 15 to 19 inches precipitation	72		
	Utica part	--	IVe-6	57	None	--	----------	--	9	84
	Judith part	--	IVe-6	57	None	--	----------	--	6	83
Uh	Utica-Judith stony loams	46	VIs-2	60	None	--	Silty, 15 to 19 inches precipitation	72		
Wa	Wet land	46	VIw-1	59	None	--	Subirrigated	71	4	83
Wb	Winifred clay loam, 0 to 4 percent slopes	47	IIe-1	53	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wc	Winifred clay loam, 4 to 8 percent slopes	47	IIIe-2	54	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wd	Winifred clay loam, 8 to 15 percent slopes	47	IVe-2	56	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wf	Winifred cobbly clay loam, 2 to 8 percent slopes	47	IIIe-2	54	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wh	Winifred cobbly clay loam, 8 to 15 percent slopes	47	IVe-2	56	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wk	Winifred-Judith clay loams	48	IVe-2	56	None	--	Clayey, 15 to 19 inches precipitation	72	3	82
Wm	Winifred-Rhoades clay loams	48	-------	--	-------	--	Clayey, 15 to 19 inches precipitation	72		
	Winifred part	--	IIIe-2	54	None	--	----------	--	3	82
	Rhoades part	--	IIIs-1	55	None	--	----------	--	10	84

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil name	Page	Dryland capability unit: Symbol	Page	Irrigated capability unit: Symbol	Page	Range site: Name	Page	Windbreak suitability group: Number	Page
Wn	Winifred-Utica clay loams---	48	-----	--	-------	--	Thin Clayey	73		
	Winifred part----------	--	VIe-3	58	None	--	----------	--	None	--
	Utica part----------	--	VIe-6	59	None	--	----------	--	None	--
Wo	Woodhurst stony loam--------	48	VIIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Wp	Woodhurst-Alder stony complex----------	49	VIIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
Wr	Woodhurst-Loberg complex----	49								
	Woodhurst part---------	--	VIIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Loberg part----------	--	VIe-7	59	None	--	None	--	None	--
Ws	Woodhurst-Spring Creek stony complex----------	49								
	Woodhurst part---------	--	VIIs-1	60	None	--	Silty, 20 to 24 inches precipitation	75	None	--
	Spring Creek part------	--	VIIs-2	61	None	--	Shallow	73	None	--
Wt	Woodhurst-Teton-Cheadle soils----------	49	-------	--	-------	--	Silty, 20 to 24 inches precipitation	75		
	Woodhurst part---------	--	VIIs-1	60	None	--	----------	--	None	--
	Teton part----------	--	VIs-1	60	None	--	----------	--	None	--
	Cheadle part----------	--	VIIs-2	61	None	--	----------	--	None	--

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SOIL LEGEND

SYMBOL	NAME
Aa	Absarokee clay loam, 2 to 8 percent slopes
Ab	Absarokee clay loam, 8 to 15 percent slopes
Ac	Absarokee silty clay, 2 to 8 percent slopes
Ad	Absarokee–Cheadle channery loams, 2 to 8 percent slopes
Af	Absarokee–Cheadle channery loams, 8 to 15 percent slopes, eroded
Ag	Absarokee–Cheadle stony loams
Ah	Absarokee–Maginnis channery clay loams, 2 to 8 percent slopes
Ak	Adel loam, 2 to 8 percent slopes
Al	Adel loam, 8 to 18 percent slopes
Am	Adel silt loam, terrace
An	Alder clay loam, 2 to 8 percent slopes
Ao	Alder clay loam, 8 to 15 percent slopes
Ap	Alder stony clay loam, 8 to 15 percent slopes
Ar	Alder–Maginnis channery clay loams, 2 to 8 percent slopes
As	Alder–Maginnis complex, 8 to 35 percent slopes
At	Arvada–Beckton cobbly clay loams
Au	Arvada–Beckton complex, saline
Av	Arvada–Laurel complex
Aw	Arvada–Terrad clays
Ax	Ashuelot gravelly loam
Ba	Bainville loam
Bb	Beckton loam
Bc	Beckton–Arvada clay loams
Bd	Bedkton–Danvers clay loams
Bf	Beckton–Savage complex
Bg	Blaine–Spring Creek loams, 2 to 8 percent slopes
Bh	Blaine–Spring Creek stony loams
Bk	Blythe loam, 2 to 4 percent slopes
Bm	Blythe loam, 4 to 8 percent slopes
Bo	Bowdoin silty clay, low clay variant
Bp	Bridger loam, 2 to 4 percent slopes
Br	Bridger loam, 4 to 15 percent slopes
Bs	Bridger stony loam
Ca	Castle clay, 4 to 15 percent slopes
Cb	Castle clay, 15 to 35 percent slopes
Cc	Castle complex
Cd	Chama clay loam, 4 to 8 percent slopes
Cf	Chama–Midway clay loams, 4 to 8 percent slopes
Cg	Chama–Midway clay loams, 8 to 15 percent slopes
Ch	Cheadle–Big Timber–Rock outcrop complex
Ck	Cheadle channery loam, 2 to 8 percent slopes
Cm	Cheadle channery loam, 8 to 15 percent slopes
Cn	Cheadle loam, 2 to 8 percent slopes
Co	Cheadle loam, 8 to 15 percent slopes
Cp	Cheadle stony loam
Cr	Cheadle–Rock outcrop complex
Cs	Cheadle–Duncom–Rock outcrop complex
Ct	Clayey alluvial land
Cu	Cobbly alluvial land
Cv	Colvin–Lamoure clay loams
Cw	Cowood stony loam
Cx	Cowood–Rock outcrop complex
Da	Danvers clay loam, 0 to 2 percent slopes
Db	Danvers clay loam, 2 to 4 percent slopes
Dc	Danvers clay loam, 4 to 8 percent slopes
Dd	Danvers cobbly clay loam, 0 to 4 percent slopes
Df	Danvers cobbly clay loam, 4 to 8 percent slopes
Dg	Danvers cobbly clay loam, 8 to 15 percent slopes
Dh	Danvers gravelly clay loam, 0 to 4 percent slopes
Dk	Danvers stony clay loam, 2 to 4 percent slopes
Dm	Danvers–Judith clay loams, 0 to 2 percent slopes
Dn	Danvers–Judith clay loams, 2 to 4 percent slopes
Do	Danvers–Judith clay loams, shale substratum, 0 to 4 percent slopes
Dp	Danvers–Judith gravelly clay loams, 0 to 2 percent slopes
Dr	Darret clay loam, 8 to 15 percent slopes
Ds	Darret stony clay loam
Dt	Darret–Cheadle complex, 2 to 8 percent slopes
Du	Darret–Cheadle complex, 8 to 35 percent slopes
Dv	Darret–Utica complex
Dw	Dimmick clay
Dx	Duncom stony loam
Dy	Duncom–Rock outcrop complex
Dz	Duncom–Skaggs–Rock outcrop complex
Fa	Fargo–Hegne silty clays
Fc	Fergus clay loam, 0 to 2 percent slopes
Fd	Fergus clay loam, 2 to 4 percent slopes
Ff	Fergus clay loam, 4 to 8 percent slopes
Fh	Fergus clay loam, 8 to 15 percent sloes
Fs	Fergus silty clay loam, shale substratum, 2 to 8 percent slopes
Ga	Gallatin clay loam
Gb	Gallatin loam
Gc	Gallatin loam, clay substratum
Gd	Gallatin soils, wet
Gr	Gallatin and Raynesford loams
Hu	Hughesville– Duncom complex
Ja	Judith–Ashuelot gravelly loams, 0 to 4 percent slopes
Jb	Judith clay loam, 0 to 2 percent slopes
Jc	Judith clay loam, 2 to 4 percent slopes
Jd	Judith clay loam, 4 to 8 percent slopes
Jf	Judith clay loam, low terrace
Jh	Judith cobbly clay loam, 0 to 4 percent slopes
Jk	Judith cobbly clay loam, low terrace, 0 to 4 percent slopes
Jl	Judith gravelly clay loam, 0 to 2 percent slopes
Jm	Judith gravelly clay loam, 2 to 4 percent slopes
Jn	Judith gravelly clay loam, 4 to 8 percent slopes
Jo	Judith gravelly clay loam, low terrace, 0 to 4 percent slopes
Jp	Judith–Danvers gravelly clay loams, 0 to 4 percent slopes
Jr	Judith and Raynesford stony loams, 2 to 8 percent slopes
Js	Judith and Raynesford stony loams, 8 to 15 percent slopes
Jt	Judith and Savage soils
Ju	Judith–Utica gravelly loams, 4 to 8 percent slopes
Jv	Judith–Utica gravelly loams, 8 to 15 percent slopes
La	Lismas–Pierre clays
Lc	Lismas–Shale outcrop complex
Lh	Little Horn stony loam
Lo	Loamy alluvial land
Lr	Loberg stony loam
Ls	Loberg–Sapphire complex
Ma	Maginnis cobbly clay loam
Mb	Maginnis–Absarokee channery clay loams
Mc	Maginnis–Alder channery clay loams
Mw	Midway clay loam
Mx	Midway–Shale outcrop complex
Pc	Pierre clay, 2 to 8 percent slopes
Pd	Pierre clay, 8 to 35 percent slopes
Pm	Promise clay, 0 to 2 percent slopes
Po	Promise clay, 2 to 8 percent slopes
Pp	Promise clay, 8 to 15 percent slopes
Pr	Promise cobbly clay
Ra	Raynesford and Adel loams, 2 to 4 percent slopes
Rd	Raynesford and Adel loams, 4 to 8 percent slopes
Rf	Raynesford and Adel loams, 8 to 15 percent slopes
Rn	Raynesford and Adel stony loams, 4 to 15 percent slopes
Ro	Rhoades–Arvada complex
Sa	Saline land
Sb	Sapphire soils
Sc	Sapphire–Cheadle complex
Sd	Savage silty clay, 0 to 2 percent slopes
Se	Savage silty clay, 2 to 4 percent slopes
Sf	Savage silty clay, 4 to 8 percent slopes
Sg	Savage silty clay loam, 0 to 2 percent slopes
Sh	Savage silty clay loam, 2 to 4 percent slopes
Sk	Savage silty clay loam, 4 to 8 percent slopes
Sl	Skaggs loam
Sm	Skaggs clay loam, 4 to 8 percent slopes
Sn	Skaggs clay loam, 8 to 15 percent slopes
So	Skaggs stony clay loam
Sp	Skaggs–Cheadle complex
Sr	Skaggs–Duncom stony clay loams
Ss	Skaggs–Raynesford loams, 8 to 35 percent slopes
St	Skaggs–Duncom–Hughesville complex
Su	Slocum loam
Sv	Spring Creek–Blaine stony loams
Sw	Straw clay loam, 0 to 2 percent slopes
Sx	Straw clay loam, 2 to 4 percent slopes
Sy	Straw clay loam, gravelly substratum
Ta	Terrad clay, 2 to 8 percent slopes
Tb	Terrad clay, 8 to 35 percent slopes
Tc	Terrad silty clay, 0 to 2 percent slopes
Td	Teton loam, 2 to 8 percent slopes
Tf	Teton loam, 8 to 15 percent slopes
Th	Teton–Adel stony loams
Tk	Teton–Cheadle channery loams, 4 to 15 percent slopes
Tm	Teton–Cheadle stony loams, 4 to 15 percent slopes
Tn	Teton–Cheadle stony loams, 15 to 35 percent slopes
To	Twin Creek loam, 2 to 4 percent slopes
Tp	Twin Creek loam, 4 to 8 percent slopes
Tr	Twin Creek loam, 8 to 15 percent slopes
Tw	Twin Creek clay loam, 0 to 2 percent slopes
Ua	Utica gravelly loam, 2 to 8 percent slopes
Ub	Utica gravelly loam, 8 to 35 percent slopes
Ug	Utica–Judith gravelly loams, sandy substratum
Uh	Utica–Judith stony loams
Wa	Wet land
Wb	Winifred clay loam, 0 to 4 percent slopes
Wc	Winifred clay loam, 4 to 8 percent slopes
Wd	Winifred clay loam, 8 to 15 percent slopes
Wf	Winifred cobbly clay loam, 2 to 8 percent slopes
Wh	Winifred cobbly clay loam, 8 to 15 percent slopes
Wk	Winifred–Judith clay loams
Wm	Winifred–Rhoades clay loams
Wn	Winifred–Utica clay loams
Wo	Woodhurst stony loam
Wp	Woodhurst–Alder stony complex
Wr	Woodhurst–Loberg complex
Ws	Woodhurst–Spring Creek stony complex
Wt	Woodhurst–Teton–Cheadle soils

Soil map constructed 1964 by Cartographic Division, Soil Conservation Service, USDA, from 1957 aerial photographs. Controlled mosaic based on Montana plane coordinate system, central zone, Lambert conformal conic projection. 1927 North American datum.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 1

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

2

CHOUTEAU COUNTY

R. 9 E. | R. 10 E.

N

LEWIS AND CLARK NATIONAL FOREST

Lava Peak

Davis Creek

Bear Creek

Martin Creek

14 13 18 17 23 24 19 20 26 25 30 29

T. 19 N.

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 9)

Cw Cx Ws Wo Gr Js Bs Jt Ug Bp Cv Bm Dk Jf Ma Sv Cc Mb Wm Ls Lr Tn Sg

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 3

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Range, township, and section corners shown on this map are indefinite.

CHOUTEAU COUNTY

R. 10 E.

T. 19 N.

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 10)

Martin Creek

Davis Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 4

(4)

CHOUTEAU COUNTY

R. 11 E.

T. 19 N.

N

(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 11)

Cottonwood Creek

Fall Creek

Daniels Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 5

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Range, township, and section corners shown on this map are indefinite.

R. 11 E. | R. 12 E.

CHOUTEAU COUNTY

T. 19 N.

(Joins sheet 4)

(Joins sheet 12)

FERGUS COUNTY

5

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 6

6

N

CASCADE COUNTY

R. 8 E.

T. 18 N.

CASCADE COUNTY

6

5

7

8

Cord Creek

(Joins sheet 7)

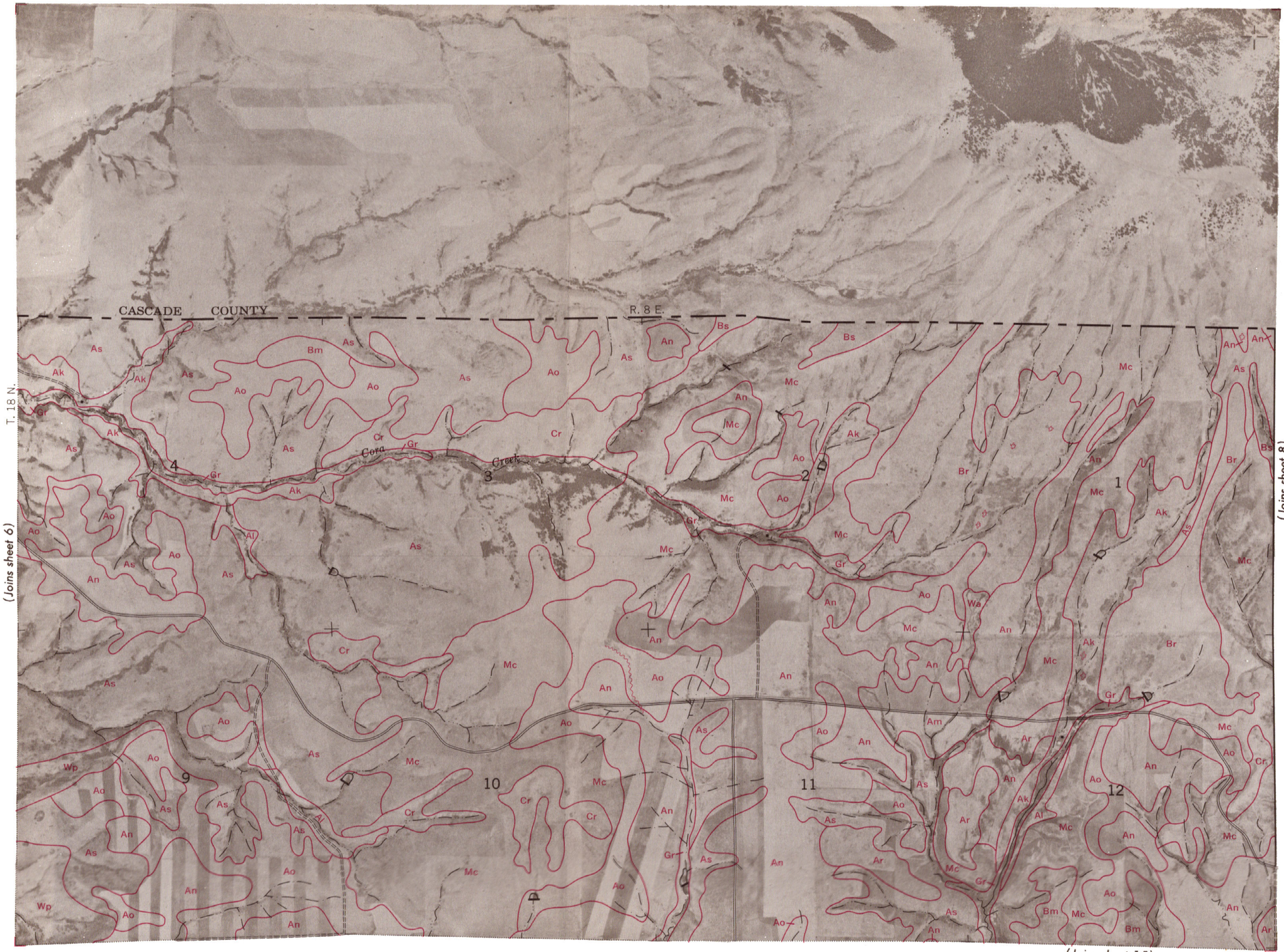
(Joins sheet 14)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 7



This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

8

(Joins sheet 1)

R. 9 E.

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

N

CASCADE COUNTY

T. 18 N. | T. 19 N.

(Joins sheet 7)

(Joins sheet 9)

(Joins sheet 16)

Arrow Creek

Bryan Creek

Hay Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 9

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 9 E. | R. 10 E.

T. 18 N. | T. 19 N.

(Joins sheet 2)

(Joins sheet 8)

(Joins sheet 10)

(Joins sheet 17)

9

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 10

(10)

N

(Joins sheet 3)

R. 10 E.

T. 18 N. | T. 19 N.

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 18)

Davis Creek

Modern Creek

Bear Creek

Brown Creek

33 34 35 36

4 3 2 1

9 10 11 12

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 100

100

N

R. 11 E.

(Joins sheet 93)

T. 13 N. | T. 14 N.

(Joins sheet 101)

(Joins sheet 107)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

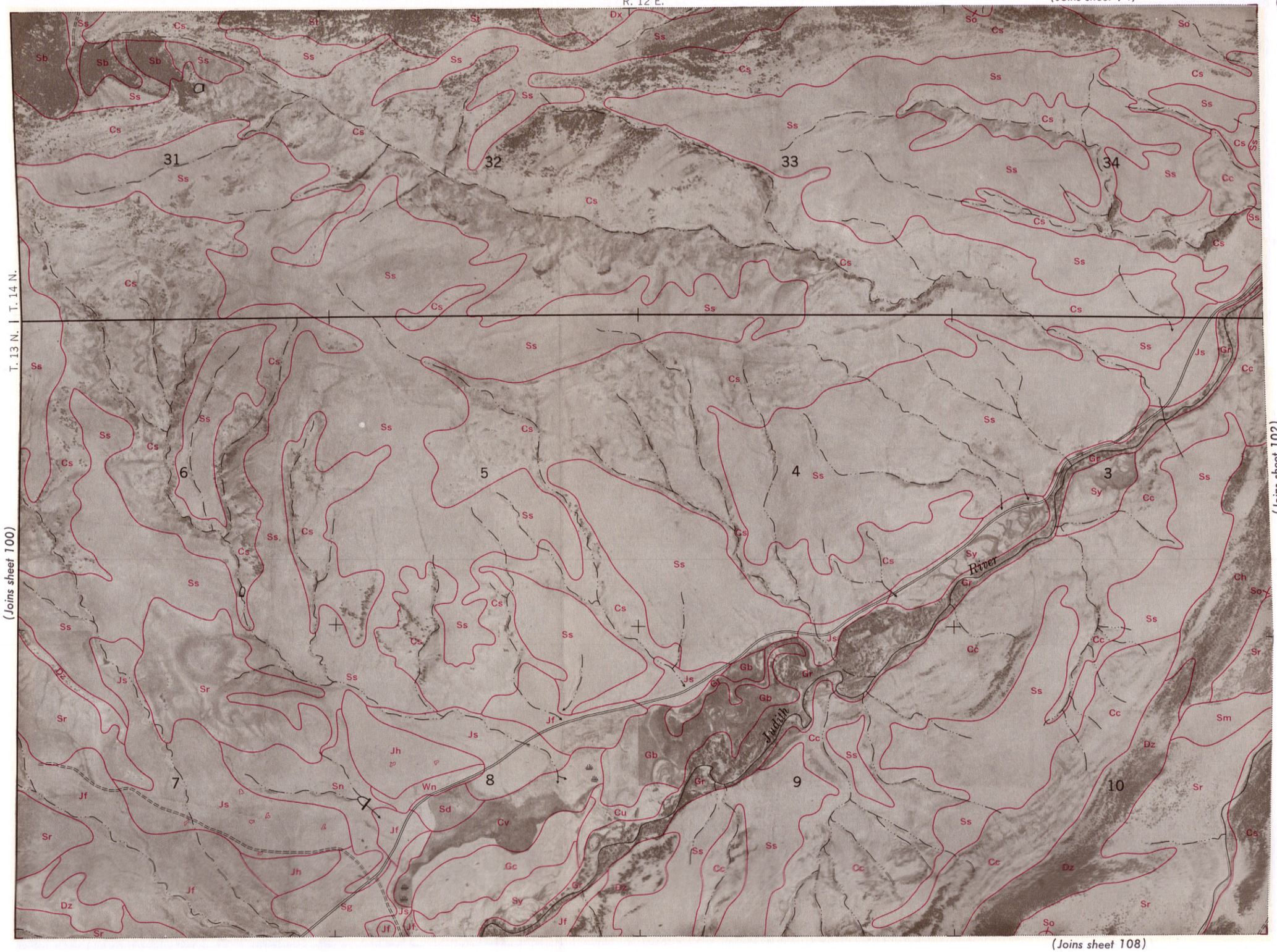
JUDITH BASIN AREA, MONTANA — SHEET NUMBER 101

(Joins sheet 94)

R. 12 E.

T. 14 N.

T. 13 N.



(Joins sheet 100)

(Joins sheet 102)

(Joins sheet 108)

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 102

(Joins sheet 95)

R. 12 E. | R. 13 E.

T. 13 N. | T. 14 N.

(Joins sheet 101)

(Joins sheet 103)

(Joins sheet 109)

Judith River

Waite Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 103

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 13 E.

(Joins sheet 96)

103

N

T. 13 N. | T. 14 N.

(Joins sheet 102)

(Joins sheet 104)

(Joins sheet 110)

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 104

104

(Joins sheet 97)

R. 14 E.

N

T. 13 N. | T. 14 N.

(Joins sheet 103)

(Joins sheet 105)

(Joins sheet 111)

Coulee

Hauek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 105

R. 14 E. | R. 15 E.

T. 14 N. | T. 13 N.

Coulee
Gr
Sh
Jv
Wa
Jl
35
36
Jm
Wk
Wn
Jn
Ja
Gb
Ub
Wc
Wd
Lo
Wb
Wk
Gr
Jl
Wn
Jv
Sw
Wd
Wn
Jm
Wn
Po
Gr
Sw
Pc
Bc
Pp
Po
Gr
Sd
Pc
Po
Po
Pp
Pp
Pp
Po
Gr
Wd
Wn
31
32
Wc
Pp
Wn
Po
Bc
Sw
Pc
Pp
Po
Po
Pp
Pp
Wn
Dp
Wn
Jm
Pp
Wn
Wn
Jm
Wn
Jm
Wn
Jm
Wn
Jn
Dp
Jv
Wn
Ja
Wn
Jm
Wn
Jm
Wn
Jn
Ja
Wn
Jv
Sh
Wc
Wk
Jn
Jm
Wn
Jm
Wn
Wk
Jm
Wn
Wn
Wn
Jm
Wn
Wn
Jm
Wn
Wn
Jm

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 106

106

(Joins sheet 99)

R. 15 E.

N

T. 13 N. | T. 14 N.

(Joins sheet 105)

(Joins sheet 113)

FERGUS COUNTY

FERGUS COUNTY

Sipple

GREAT NORTHERN

PACIFIC AND ST PAUL

MILWAUKEE

CHICAGO

Judith River

Big Coulee

Ross Fork

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 11 E.

(Joins sheet 100)

107

N

T. 13 N.

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

16 15 14 13

21 22 23 24

27 26 25

LEWIS AND CLARK NATIONAL FOREST

Yogo Creek

Judith River

LIMIT OF DETAILED SOIL SURVEY

(Joins sheet 108)

(Joins sheet 114)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 108

(108)

N

(Joins sheet 101)

R. 12 E.

T. 13 N.

(Joins sheet 107)

(Joins sheet 109)

(Joins sheet 115)

Judith River

Sections: 18, 17, 16, 15, 19, 20, 21, 22, 30, 29, 28, 27

Dz Sr Jf Sg Js Sy Gr Ss Cc Sn Jn Ub So Cs Lh Sv Bh Th Tm Gb Sf

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 109

R. 12 E. | R. 13 E.

(Joins sheet 102)

109

N

T. 13 N.

(Joins sheet 109)

(Joins sheet 110)

(Joins sheet 116)

Waite Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 11

R. 11 E.

(Joins sheet 4)

11

N

T. 18 N. | T. 19 N.

Creek

Davis

31 32 33 34

6 5 4 3

7 8 9 10

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 19)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 110

110

N

(Joins sheet 103)

R. 13 E.

T. 13 N.

(Joins sheet 109)

(Joins sheet 111)

(Joins sheet 117)

16 15 14 13

21 22 23 24

28 27 26 25

Antelope Creek

Antelope Creek

Ton West Fork

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 111

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 14 E.

(Joins sheet 104)

111

N

T. 13 N.

(Joins sheet 110)

(Joins sheet 112)

(Joins sheet 118)

Sections: 18, 17, 16, 15; 19, 20, 21, 22; 30, 29, 28, 27

Coulee

Hauck

Coulee

Big

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 112

(112)

(Joins sheet 105)

R. 14 E. | R. 15 E.

N

T. 13 N.

(Joins sheet 111)

(Joins sheet 113)

(Joins sheet 119)

Big Coulee

Big Coulee

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 113

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 106)

(Joins sheet 112)

(Joins sheet 120)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

N

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 114

(Joins sheet 107)

(114)

N

R. 11 E.

T. 13 N.

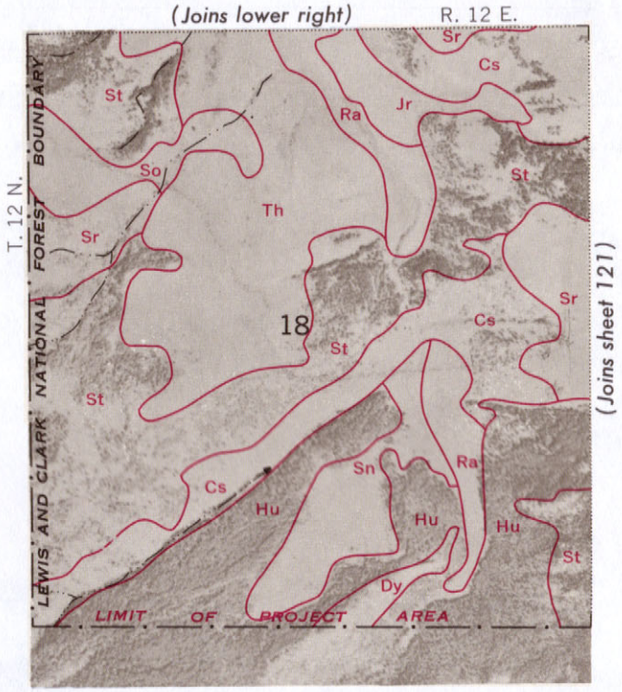
T. 12 N.

(Joins sheet 115)

(Joins lower right)

R. 12 E.

T. 12 N.



(Joins sheet 121)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

R. 12 E.

(Joins upper left)

(Joins sheet 108)

R. 12 E.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 115

115

N

T. 13 N.

T. 12 N.

31 32 33 34

5 4 3 2

8 9 10 11

Sg Wn Ua Dz Sl Sr Ss So Sf Sh Ub Jn Jv Jr Hu Cc Th Tm Td Cs Ca Ra

(Joins sheet 114)

(Joins sheet 116)

(Joins sheet 121)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 109)

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 116

116

N

R. 12 E. | R. 13 E.

T. 13 N.

T. 12 N.

35 36 31 32

1 6 5 4

12 7 8 9

Creek

Waite

Creek

Fork

Antelope

West

Antelope Creek

(Joins sheet 115)

(Joins sheet 117)

(Joins sheet 122)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 117

(Joins sheet 110)

R. 13 E.

117

N

T. 13 N.

T. 12 N.

(Joins sheet 116)

(Joins sheet 118)

(Joins sheet 123)

R. 14 E.

R. 13 E.

Antelope Creek

West Fork Antelope Creek

Big Coulee

Coyote Creek

Scale 1:20000

1 Mile

½

0

5000 Feet

0

Range, township, and section corners shown on this map are indefinite.

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 118

(118)

(Joins sheet 111)

R. 14 E.

T. 13 N.

T. 12 N.

(Joins sheet 117)

(Joins sheet 119)

(Joins sheet 124)

N

Coulee

Hauck

Big

Coulee

Creek

Coyote

Creek

Coyote

Creek

Buffalo

31 32 33 34

5 4 3 2

8 9 10 11

Ax Jl Jn Dm Jp Gb Ub Jm Jv Wc Wd Sy Gr Wk Pp Wn Jt Sg Dp Po Sd Sh Da Do Ab Aa Mb Fd Ga Sw Sx Ac Cp Bc Ua Wb

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 119

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 112)

R. 14 E. | R. 15 E.

119

N

T. 13 N.

T. 12 N.

(Joins sheet 118)

(Joins sheet 120)

(Joins sheet 125)

FERGUS COUNTY

Coulee Cr. Creek

Buffalo Creek

Buffalo Creek

R. 14 E. | R. 15 E.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 12

12

N

(Joins sheet 5)

R. 11 E. | R. 12 E.

T. 18 N. | T. 19 N.

FERGUS COUNTY

(Joins sheet 11)

(Joins sheet 13)

(Joins sheet 20)

Davis Creek

Arrow Creek

Creek

CHICAGO MILWAUKEE ST PAUL AND PACIFIC

Soil symbols: Pm, La, Lc, Bc, Po, Pd, Pc, Sv, Pp, Ro, Mb, Wb, Ct, Gr, Sy, Wn, Jp

Sections: 35, 36, 31, 32, 2, 1, 6, 5, 11, 12, 7, 8

0 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 120

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 121

R. 12 E.

(Joins sheet 115)

121

N

(Joins inset, sheet 114)

T. 12 N.

(Joins sheet 122)

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

LIMIT OF SURVEY

Waite Creek

Sections: 17, 16, 15, 14, 22, 23, 26

Soil symbols: Cs, Sr, Jn, Jv, Wn, Jr, Ua, Ub, St, Hu, Dy, Ss, Cc, Ca, Dz, Th, Ra, Ch, Dx, Cp

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 122

(122)

N

(Joins sheet 116)

R. 12 E. | R. 13 E.

T. 12 N.

(Joins sheet 121)

(Joins sheet 123)

Ss Ch So Sr Dz Th Td Dx Cb Tn Cp Cm Cr Tp Cc Dy Jm Js

13 18 17 16 24 19 20 21 25 30 29 28

Creek

Antelope

LEWIS AND CLARK NATIONAL FOREST

LIMIT OF DETAILED SOIL SURVEY

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 123

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 13 E. R. 14 E.

T. 12 N.

(Joins sheet 117)

(Joins sheet 122)

(Joins sheet 124)

(Joins inset, sheet 129)

123

N

Coyote Creek

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

LIMIT OF SOIL SURVEY

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 124

124

N

(Joins sheet 118)

R. 14 E.

T. 12 N.

(Joins sheet 123)

(Joins sheet 125)

(Joins sheet 129)

Buffalo Creek

LEWIS AND CLARK NATIONAL FOREST

LIMIT OF SOIL SURVEY

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

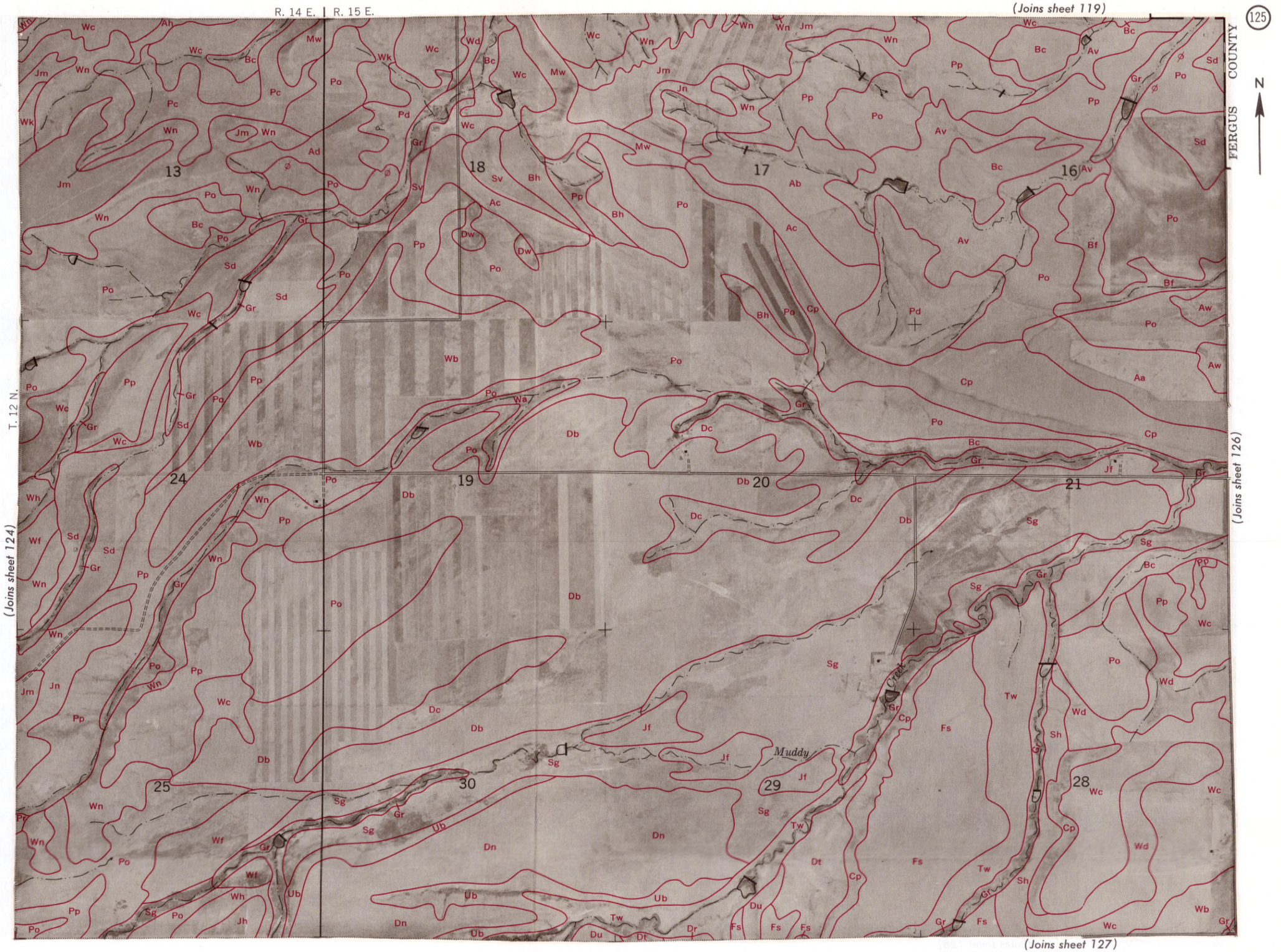
0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experimental Station.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

126

N

FERGUS COUNTY

Creek

Judith

GREAT NORTHERN

CHICAGO MILWAUKEE ST PAUL AND PACIFIC

River

Judith Fork

Ross

FERGUS COUNTY

R. 15 E. | R. 16 E.

T. 12 N.

15 14 22 23 27 26 25 30

Po Sd Bf Gr Aw Jf Wc Mw Wd Sw Ug Wn Aa Sg Cp Mb Wb Pc Wh La Jp Pp Sf Ah Dd Dw Bc Av Sx Dn Ga

191

(Joins sheet 125)

(Joins sheet 128)

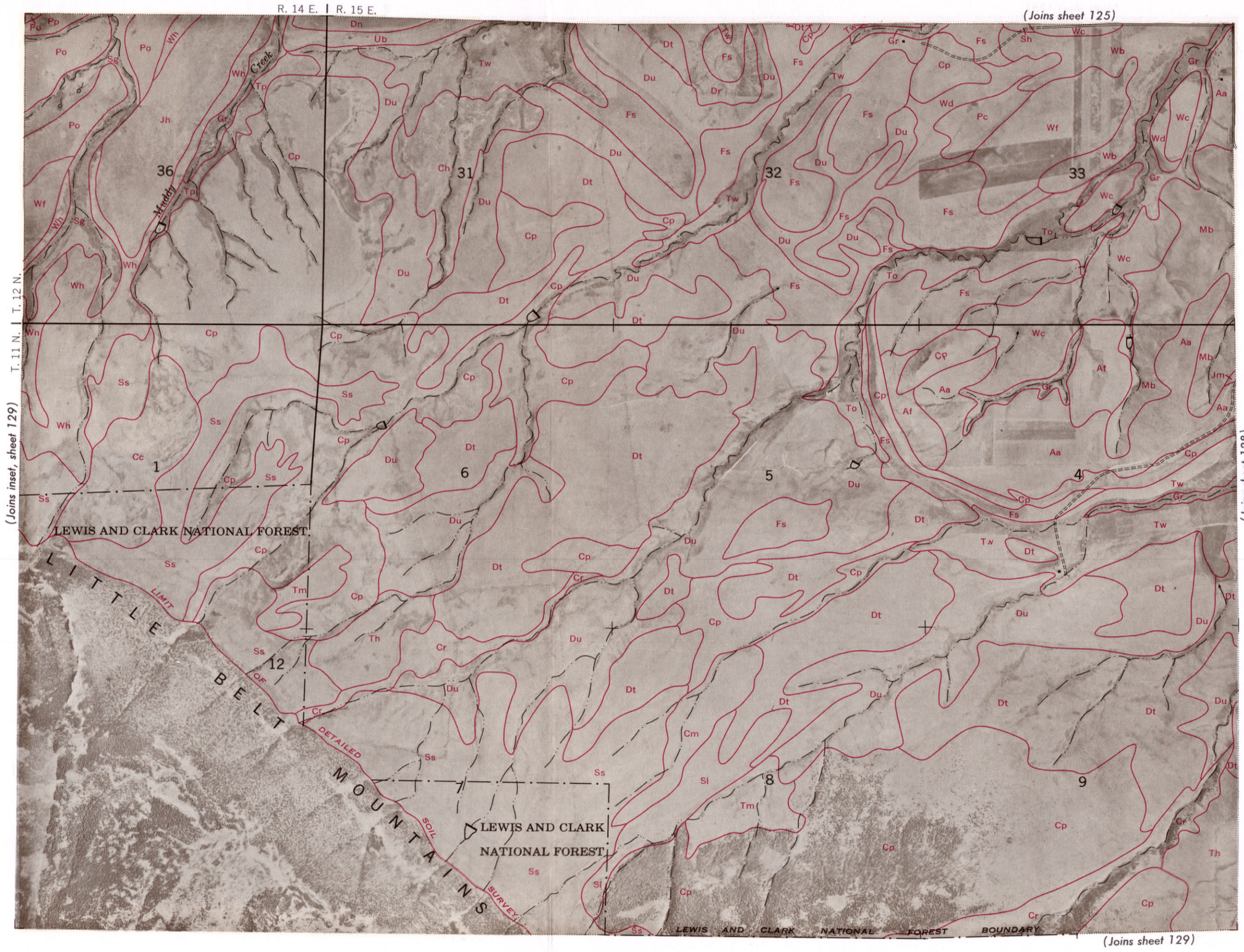
0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.



JUDITH BASIN AREA, MONTANA — SHEET NUMBER 128

(128)

(Joins sheet 126)

R. 15 E. | R. 16 E.

T. 11 N. | T. 12 N.

N

Ross Fork Judith River

C M St P & P

191

GREAT NORTHERN

Barrows

Red Bluff Creek

Judith River

FERGUS COUNTY

(Joins sheet 127)

(Joins sheet 130)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 129

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 15 E. (Joins sheet 127) 129

T. 11 N.

(Joins sheet 130)

R. 14 E. (Joins sheet 124)

T. 12 N.

T. 11 N.

(Joins sheet 127)

R. 14 E. R. 13 E. T. 12 N. (Joins sheet 123)

N

LITTLE BELT MOUNTAINS

WHEATLAND COUNTY

LEWIS AND CLARK NATIONAL FOREST

NATIONAL FOREST

NAT. FOREST

DETAILED SOIL SURVEY

LIMIT OF SOIL SURVEY

18 17 16 21 32 33 34 35 36 31 3 2

Ss Cp Cr Th Tn Dz Dt So Ub Jh Jt Pr Jv Po Pp Wc Wd Wf Wn Wh Sd SB

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

13

N

FERGUS COUNTY

R. 12 E.

T. 18 N.

(Joins sheet 12)

(Joins sheet 21)

FERGUS COUNTY

CHICAGO MILWAUKEE ST PAUL AND PACIFIC

Arrow Creek

Surprise Creek

230

Lc Gr Ct Ct Gr Lc Lc Lc Ct Lc Ct Pm Pm Dw Pm Da Da Da Da Da Da Da Da Dn Dn Dn

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 130

130

N

(Joins sheet 128)

(Joins sheet 129)

R. 15 E. | R. 16 E.

T. 11 N.

FOREST BOUNDARY

LIMIT OF SURVEY

WHEATLAND COUNTY

FERGUS COUNTY

CHICAGO GREAT NORTHERN MILWAUKEE ST PAUL AND PACIFIC

15 14 13 18 22 23 24 19

Th Dt Du Dr Fs Ad Aa Af Cp Tw To Wd Wc Wn Jm Dw Gr Do Sd Bc Po Pp Wa Jn Wk Cg Cf Cd Dz So Mw Pc Wi Lo Wn Gr

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 14

14

N

R. 8 E.

(Joins sheet 6)

CASCADE COUNTY

R. 7 E.

T. 18 N.

(Joins sheet 15)

(Joins sheet 22)

(Joins sheet 23)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 15

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 8 E.

T. 18 N.

(Joins sheet 14)

(Joins sheet 7)

(Joins sheet 16)

(Joins sheet 23) | (Joins sheet 24)

15

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

16

(Joins sheet 8)

R. 9 E.

T. 18 N.

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 24) | (Joins sheet 25)

Spion Kop

GREAT NORTHERN

Brush Creek

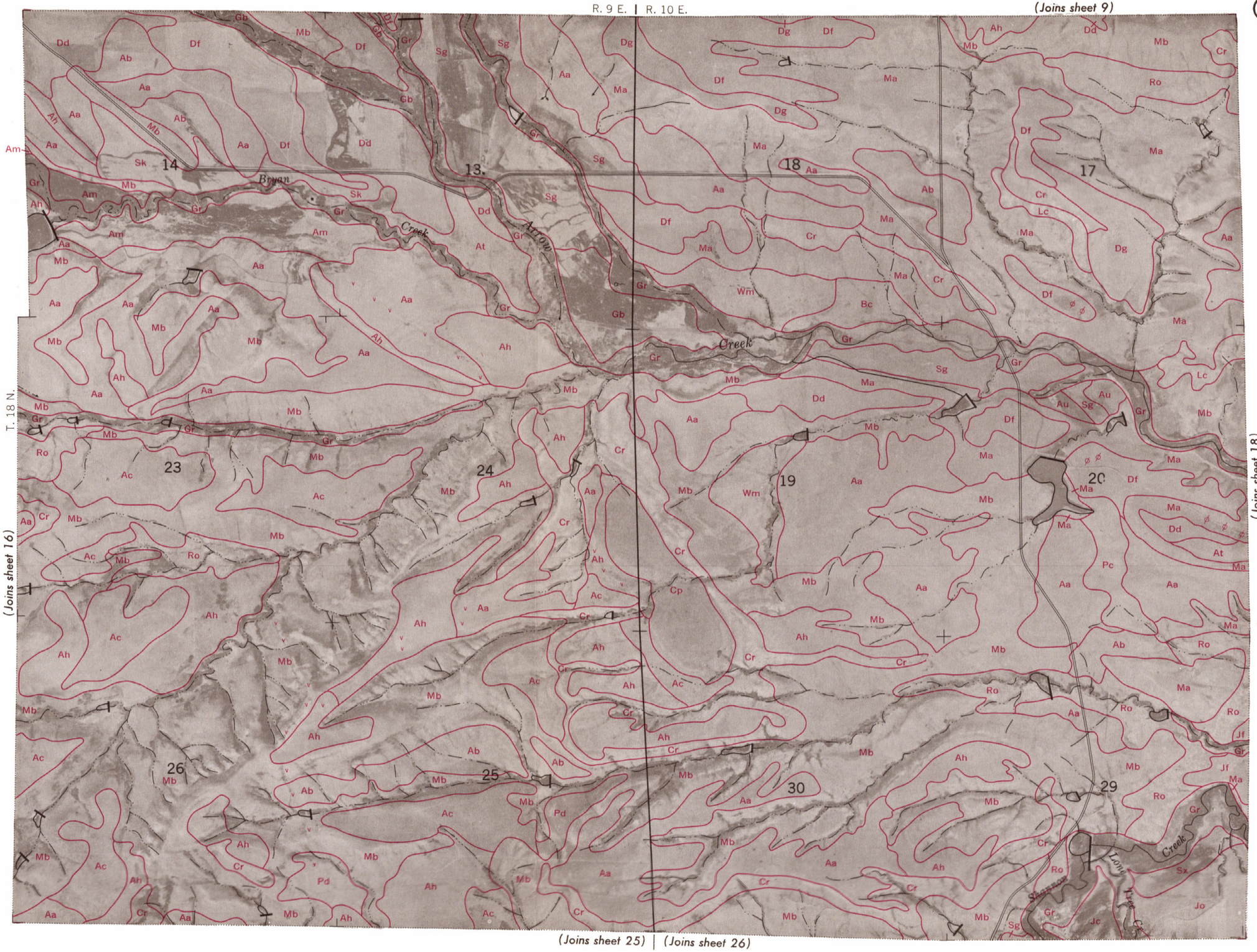
Hay Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 17



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Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 18

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 19

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 20

(20)

N

(Joins sheet 12)

R. 11 E. | R. 12 E.

T. 18 N.

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 28) | (Joins sheet 29)

Arrow Creek

Surprise Creek

C. M. St. P. & P.

14 13 18 17

23 24 19 20

26 25 30 29

Aa Bc Dm Jn Jv Mb Mx Pm Wb Wc Wd Wn Pp Sa Ah Dp Jm Ub Ua Da Ma Db Dc Dm Gr Lc Ct Po Wb Wn Jp

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 21

R. 12 E.

(Joins sheet 13)

21

N

T. 18 N.

(Joins sheet 20)

16 15 14 13

21 22 23 24

28 27 26 25

(230)

(Joins sheet 29) (Joins sheet 30)

FERGUS COUNTY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 22

22

R. 7 E.

N

(Joins lower right)

(Joins sheet 32)

CASCADE COUNTY

CASCADE COUNTY

13

Tn

An

(Joins sheet 14)

GREAT NORTHERN

Otter Creek

Ch

Du

Gr

Jt

Tw

Jr

Tn

36

Du

Cp

Dt

Fs

Tn

Dt

Du

Dt

Cp

Dt

1

Tn

Dt

Du

Dt

Cp

Fs

Cr

Tm

Tn

Fs

Cp

Fs

Cr

12

Tn

An

T. 17 N. | T. 18 N.

(Joins sheet 23)

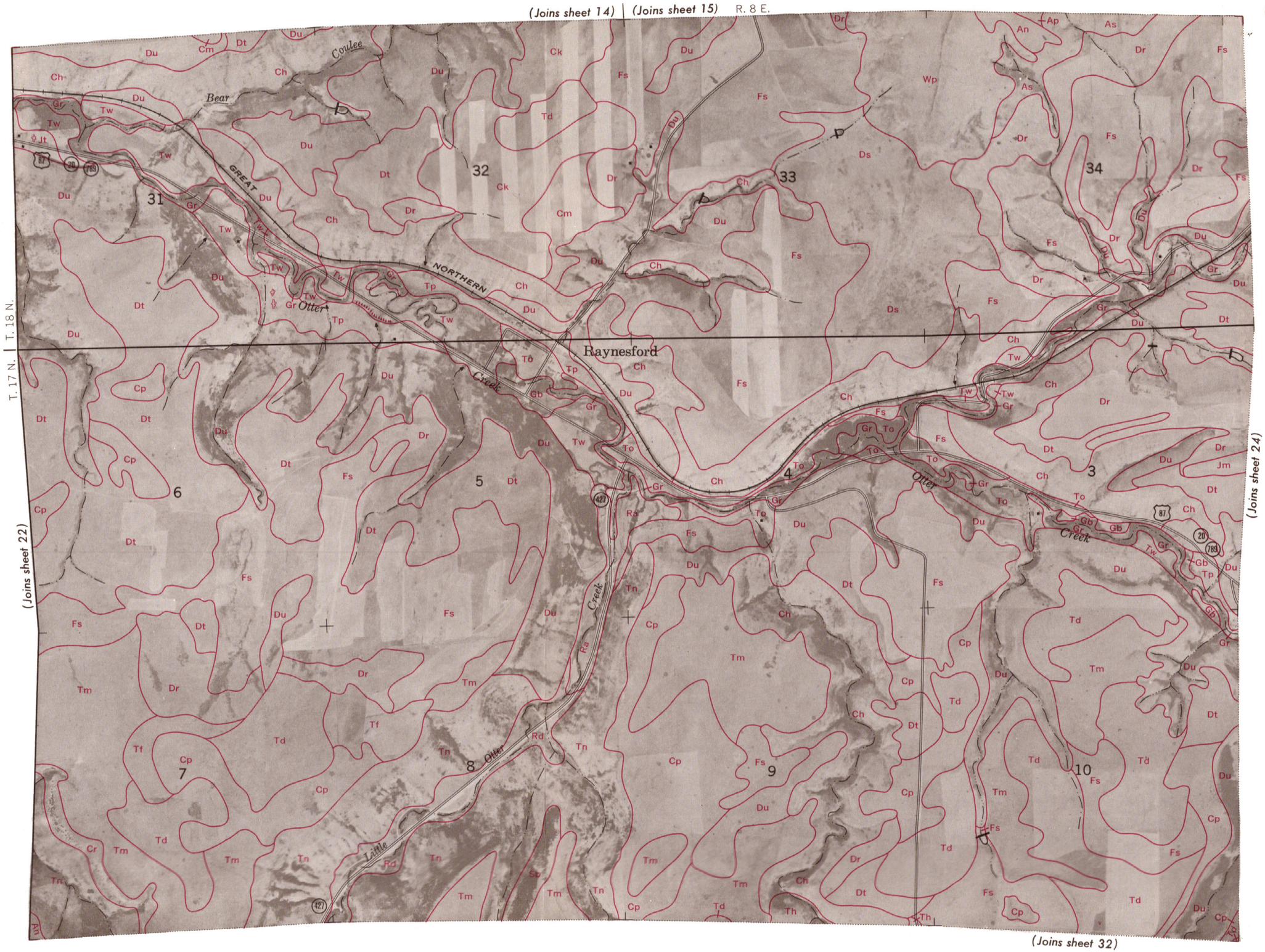
(Joins inset, upper left)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 23



This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 24

(24)

N

(Joins sheet 15) R. 8 E. | R. 9 E. Ro (Joins sheet 16)

GREAT NORTHERN

T. 17 N. | T. 18 N.

(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 33)

Otter Creek

87 20 789

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 25

(Joins sheet 16) | (Joins sheet 17)

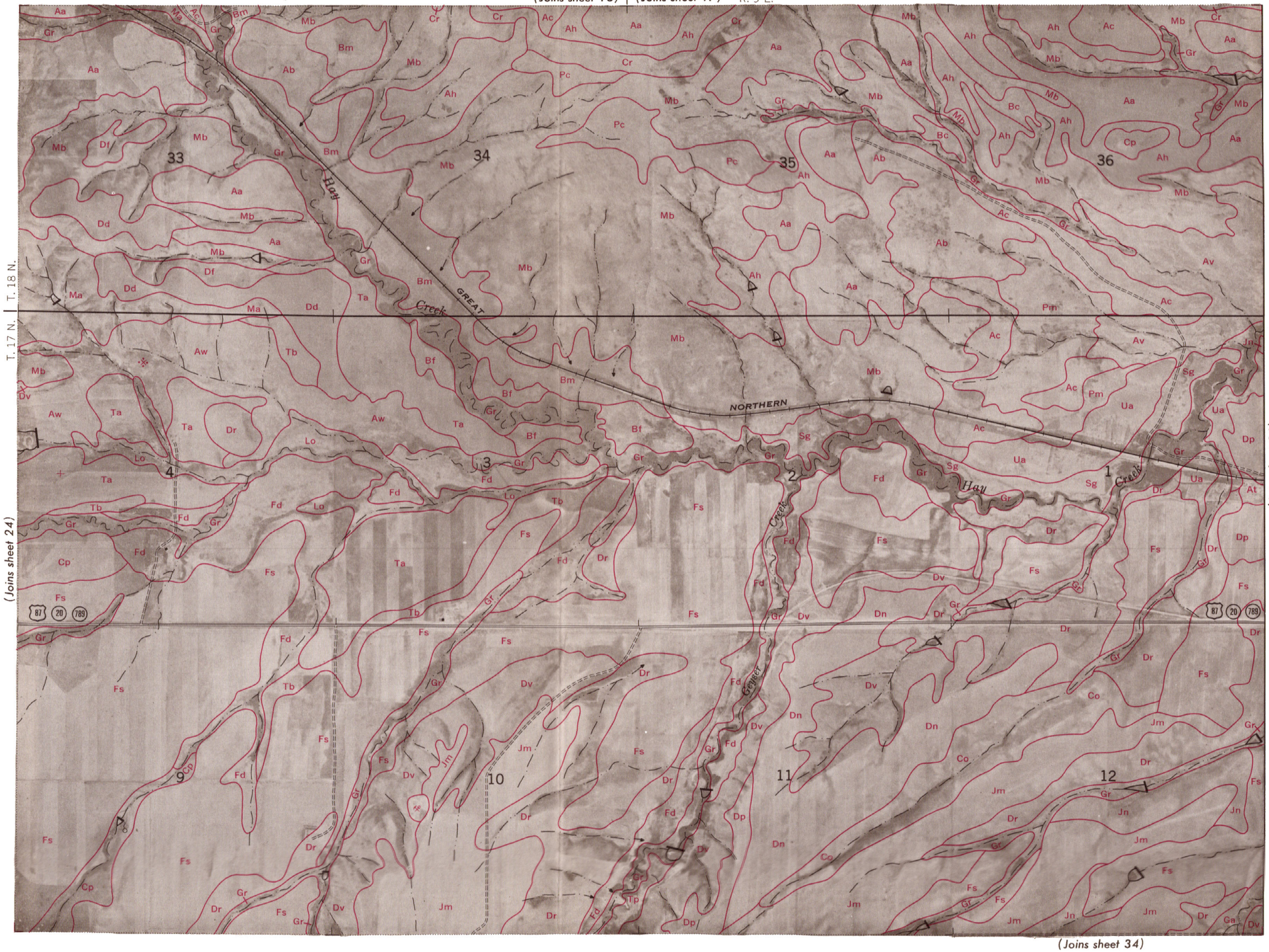
R. 9 E.

25

N

T. 18 N.

T. 17 N.



(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 34)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 26

(26)

(Joins sheet 17) | (Joins sheet 18) R. 10 E.

N

T. 17 N. | T. 18 N.

(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 35)

Geyser

GREAT NORTHERN

Lone Tree Creek

Shannon Creek

Hay Coulee

Crow Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 27

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 18) R. 10 E. | R. 11 E. (Joins sheet 19)

T. 18 N. | T. 17 N.

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 36)

Dripping Creek

Vat Creek

GREAT NORTHERN

Merino

35 36 31 32 2 1 6 5 11 12 7 8

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

N

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 28

(28)

(Joins sheet 19) | (Joins sheet 20) R. 11 E.

N

T. 17 N. | T. 18 N.

(Joins sheet 27)

(Joins sheet 29)

(Joins sheet 37)

GREAT NORTHERN

Surprise Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 29

(Joins sheet 20)

(Joins sheet 21)

R. 12 E.

29

N

T. 18 N.

T. 17 N.

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 38)

Surprise Creek

Meadow Creek

Wolf Creek

230

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

(Joins sheet 21)

R. 12 E.

R. 13 E.

T. 18 N.

T. 17 N.

FERGUS COUNTY

N

Meadow Creek

Bo Creek

Wolf Creek

35 36 2 1 11 12 6 5 7 8

(Joins sheet 29)

(Joins sheet 31)

(Joins sheet 39)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 32

32

R. 8 E.

T. 17 N.

(Joins sheet 23)

(Joins inset, sheet 22)

(Joins sheet 33)

(Joins sheet 43)

CASCADE COUNTY

Little Otter Creek

427

18 17 16 15

19 20 21 22

30 29 28 27

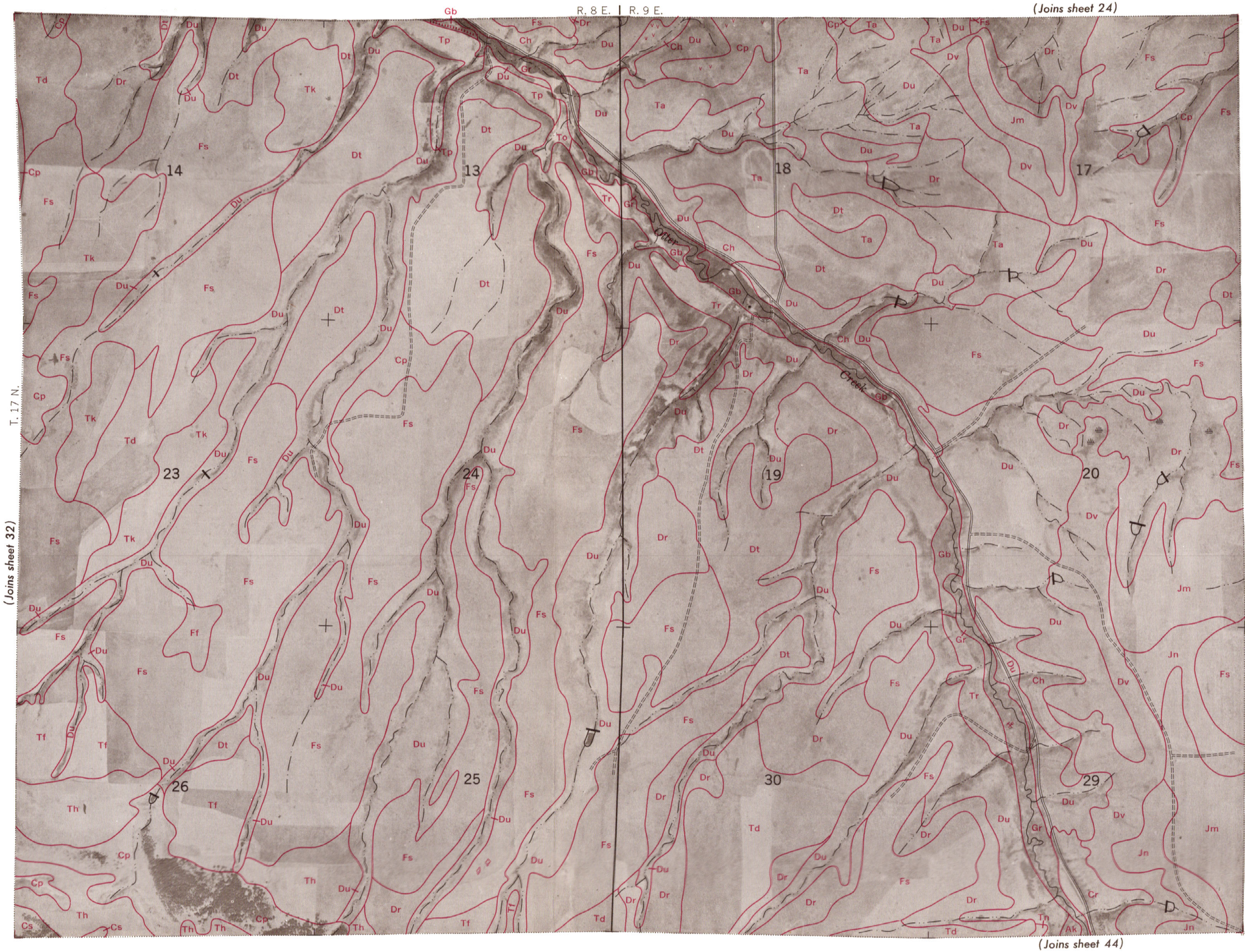
Cr An Tn Tm Th Gr Rd Wt Cs Sb Ch Fs Td Cp Du Tk Tf Dr Al Ak Rf Sr Hu Ra Gb Sn Wo

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 33



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 34

34

(Joins sheet 25)

R. 9 E.

N

T. 17 N.

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 45)

16 15 14 13

21 22 23 24

28 27 26 25

Geyser Creek

Coulee

Crow Creek

McCarthy Creek

0 ½ 1 Mile

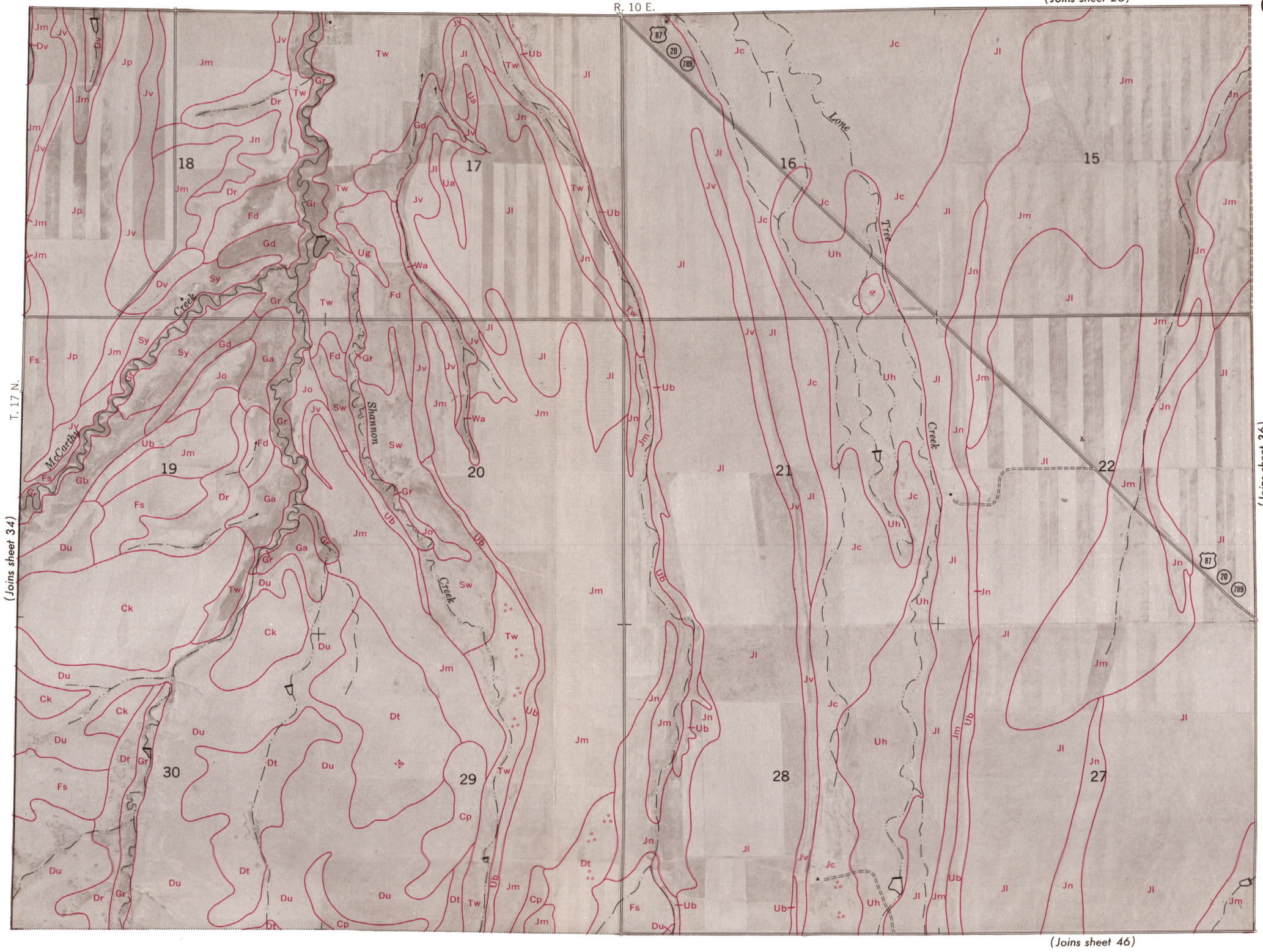
Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 35

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 36

36

(Joins sheet 27)

R. 10 E. | R. 11 E.

N

T. 17 N.

(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 47)

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 11 E.

T. 17 N.

(Joins sheet 28)

(Joins sheet 36)

(Joins sheet 38)

(Joins sheet 48)

GREAT NORTHERN

Creek

Sunrise

Meadow

Dover

16 15 14 13 21 22 23 24 27 26 25 28

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

38

(Joins sheet 29)

R. 12 E.

N

Meadow Creek

Wolf Creek

GREAT NORTHERN

18 17 16 15

19 20 21 22

30 29 28 27

T. 17 N.

(Joins sheet 37)

(Joins sheet 39)

(Joins sheet 49)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 39

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 12 E. | R. 13 E.

T. 17 N.

(Joins sheet 30)

(Joins sheet 38)

(Joins sheet 40)

(Joins sheet 50)

39

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 40

(40)

(Joins sheet 31)

R. 13 E.

FERGUS COUNTY

T. 17 N.

(Joins sheet 39)

(Joins sheet 41)

(Joins sheet 51)

N

Coyote Creek

Gr Creek

Dry Wolf Creek

16 15 14 13

21 22 23 24

28 27 26 25

Au At Wh Bb Sg Wa Wf Gr Bc Wn Dm Jp Wm Pd Sg Wh Wa Bc Wn Dm Jp Po Lo Wk Jn Dn Ub Da Jf Sh Wd Sk Wc Ws Dc Db Wa

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 41

41

N

FERGUS COUNTY

R. 14 E.

T. 17 N.

19 20 21 22

30 29 28 27

Wolf Creek

Dry Gr

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 52)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

42

N

FERGUS COUNTY

R. 14 E.

T. 17 N.

COUNTY FERGUS

23 24 25 26

Pd Wd Wc Wn Av Po Dm Lc La Pp Bc Wm Db Jf Jv Jm Mw Sk Gr Ga Cr Sage

(Joins sheet 41)

(Joins sheet 53)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 43

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

(44)

N

(Joins sheet 33)

R. 8 E. | R. 9 E.

T. 17 N.

T. 16 N.

(Joins sheet 43)

(Joins sheet 45)

(Joins sheet 56)

Otter Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 45

R. 9 E.

(Joins sheet 34)

45

N

T. 17 N.

T. 16 N.

(Joins sheet 44)

(Joins sheet 46)

(Joins sheet 57)

Geyser Creek

McCarthy Creek

McCarthy Creek

Rd

33 34 35 36

4 3 2 1

9 10 11 12

Jm Dr Fs Cr Dv Ub Ua Cp Gr Jn Tm Th Du Dt Dp Tw Cm Fd Ck Ch Gb Cs As Sc Td Tf Sn Sr

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

(46)

N

(Joins sheet 35)

R. 10 E.

T. 17 N.

T. 16 N.

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 58)

Sharron Creek

Dripping Vat Creek

Jf Creek

Tree Gr

Lone Sk

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 47

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 48

(48)

(Joins sheet 37)

R. 11 E.

T. 17 N.

T. 16 N.

(Joins sheet 47)

(Joins sheet 49)

(Joins sheet 60)

N

Creek

Meadow Creek

Sunnyrise

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 49

R. 12 E.

(Joins sheet 38)

49

N

T. 17 N.

T. 16 N.

(Joins sheet 48)

(Joins sheet 50)

(Joins sheet 61)

STANFORD

Great Northern

Wolf Creek

Skull Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

50

N

(Joins sheet 39)

R. 12 E. | R. 13 E.

T. 17 N.

T. 16 N.

(Joins sheet 49)

(Joins sheet 51)

(Joins sheet 62)

AIRWAY BEACON

Coyote Creek

Skull Creek

Dry Wolf Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 51

R. 13 E.

(Joins sheet 40)

51

N

T. 17 N.

T. 16 N.

(Joins sheet 50)

(Joins sheet 52)

(Joins sheet 63)

Dry Creek

Wolf Creek

Willow Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 52

52

R. 14 E.

(Joins sheet 41)

N

T. 17 N.

T. 16 N.

(Joins sheet 51)

(Joins sheet 53)

(Joins sheet 64)

Creek

Sage

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 53

(Joins sheet 42)

R. 14 E.

53

N

T. 17 N.

T. 16 N.

R. 15 E.

FERGUS COUNTY

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 65)

Creek

Sage

35 36 2 1 6 5 11 12 7 8

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

54

N

FERGUS COUNTY

R. 15 E.

T. 16 N.

FERGUS COUNTY

Creek

Indian

(Joins sheet 53)

(Joins sheet 66)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 55

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 8 E.

(Joins sheet 43)

55

N

T. 16 N.

(Joins sheet 56)

(Joins inset, sheet 67)

CASCADE COUNTY

LEWIS AND CLARK

NATIONAL FOREST BOUNDARY

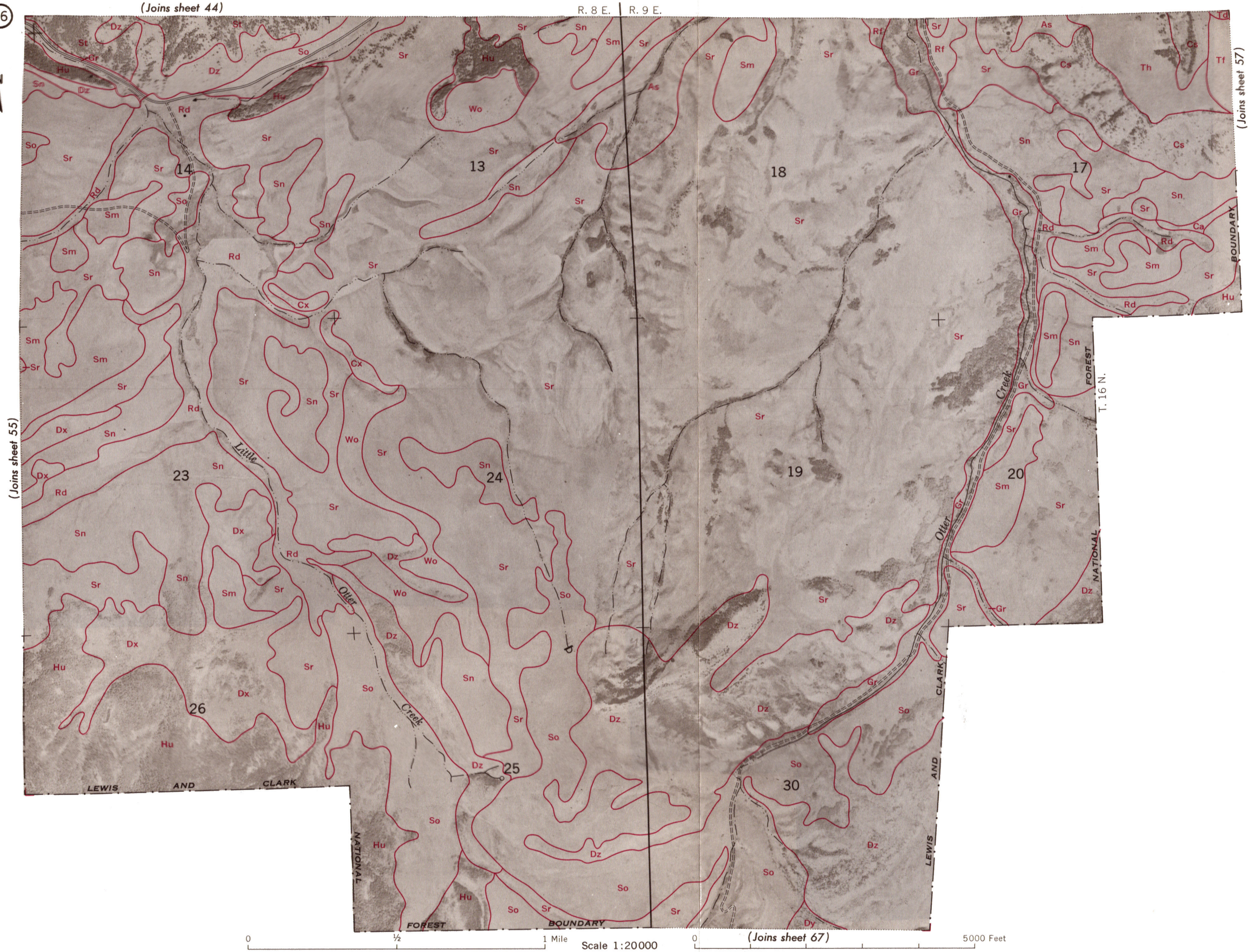
Little Otter Creek

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 56



JUDITH BASIN AREA, MONTANA — SHEET NUMBER 57

R. 9 E.

(Joins sheet 45)

57

(Joins sheet 56)

N

T. 16 N.

Td Tf Cp Sr Cs Ca Sn Hu Dy Cr Th St Ss Cc Ro

McCarthy Creek

Shannon Creek

16 15 14 13 24

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

(Joins sheet 58)

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 58

58

(Joins sheet 46)

R. 10 E.

T. 16 N.

N

(Joins sheet 57)

(Joins sheet 59)

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

(Joins inset, sheet 76)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 59

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 10 E. | R. 11 E.

T. 16 N.

(Joins sheet 47)

(Joins sheet 58)

(Joins sheet 60)

(Joins sheet 68)

59

N

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 60

(60)

N

(Joins sheet 48)

R. 11 E.

T. 16 N.

(Joins sheet 59)

(Joins sheet 61)

(Joins sheet 69)

16 15 14 13

21 22 23 24

28 27 26 25

Creek

Sun Creek

Wolf Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

R. 12 E.

(Joins sheet 49)

61

STANFORD

N

T. 16 N.

(Joins sheet 60)

(Joins sheet 62)

(Joins sheet 70)

Wolf Creek

Skull Creek

Coyote Creek

GREAT NORTHERN

17 16 18 15 19 20 21 22 30 29 28 27

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 62

62

(Joins sheet 50)

R. 12 E. | R. 13 E.

T. 16 N.

(Joins sheet 61)

(Joins sheet 63)

(Joins sheet 71)

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 63

R. 13 E.

(Joins sheet 51)

63

N

T. 16 N.

(Joins sheet 62)

(Joins sheet 64)

(Joins sheet 72)

16 15 14 13

21 22 23 24

28 27 26 25

Willow Creek

Sage Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

64

(Joins sheet 52)

R. 14 E.

T. 16 N.

N

Willow Creek

Sage Creek

18 17 16 15

19 20 21 22

30 29 28 27

(Joins sheet 63)

(Joins sheet 65)

(Joins sheet 73)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 65

R. 14 E. | R. 15 E.

(Joins sheet 53)

65

N

T. 16 N.

(Joins sheet 64)

(Joins sheet 66)

(Joins sheet 74)

Indian Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

66

(Joins sheet 54)

R. 15 E.

N

T. 16 N.

FERGUS COUNTY

16 15 14 13

21 22 23 24

28 27 26 25

Indian Creek

Louse Creek

(Joins sheet 65)

(Joins sheet 75)

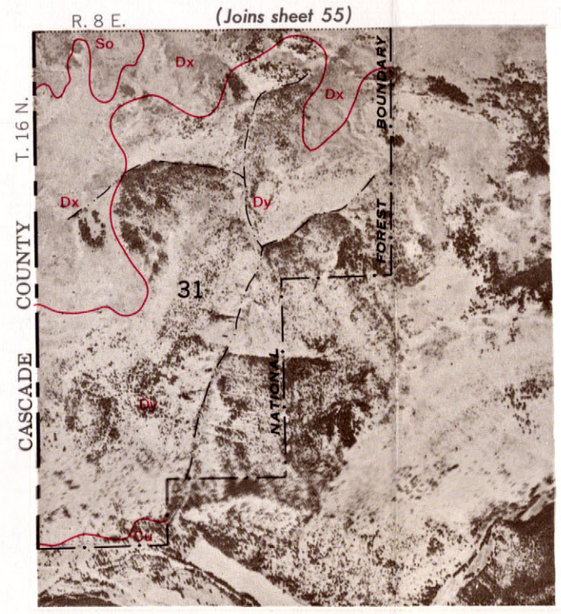
0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

67

N

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 68

(68)

N

(Joins sheet 59)

R. 10 E. | R. 11 E.

T. 16 N.

R. 15 E.

(Joins inset, sheet 76)

(Joins sheet 69)

(Joins sheet 77)

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

Dry Wolf Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 69

R. 11 E.

(Joins sheet 60)

69

N

T. 16 N.

T. 15 N.

33 34 35 36

4 3 2 1

9 10 11 12

Creek Wolf Creek Dry Wolf Creek Pennicott Creek

(Joins sheet 68)

(Joins sheet 70)

(Joins sheet 78)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 70

R. 12 E.

T. 15 N. | T. 16 N.

(70)

N

(Joins sheet 61)

(Joins sheet 69)

(Joins sheet 71)

(Joins sheet 79)

Coyote Creek

Skull Creek

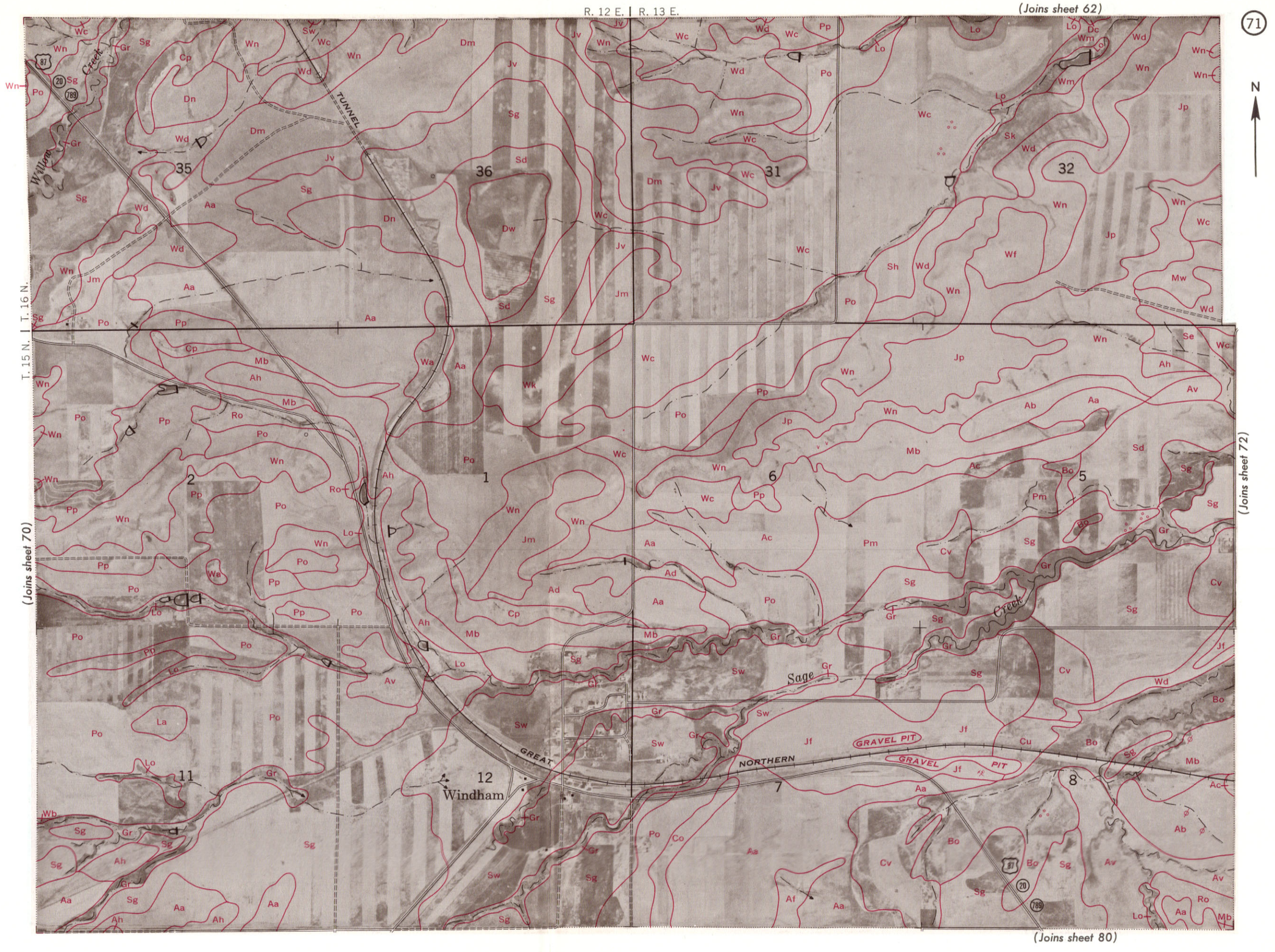
Willow Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 71



This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 72

(72)

N

(Joins sheet 63)

R. 13 E.

T. 15 N. | T. 16 N.

(Joins sheet 71)

(Joins sheet 73)

(Joins sheet 81)

Creek

Sage Creek

GREAT NORTHERN

Benchland

33 34 35 36

4 3 2 1

9 10 11 12

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 73

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 14 E.

(Joins sheet 64)

73

N

T. 16 N.

T. 15 N.

(Joins sheet 72)

(Joins sheet 74)

(Joins sheet 82)

GREAT NORTHERN

Louise Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 74

74

(Joins sheet 65)

R. 14 E. | R. 15 E.

T. 15 N. | T. 16 N.

N

(Joins sheet 73)

(Joins sheet 75)

(Joins sheet 83)

35 36 31 32

2 1 6 5

11 12 7 8

Louse Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 15 E.

(Joins sheet 66)

75

N

T. 16 N.

T. 15 N.

Kolin

Louse Creek

NORTHERN

GREAT

FERGUS COUNTY

(Joins sheet 74)

(Joins sheet 84)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

N

(Joins sheet 58)

R. 10 E.

T. 15 N. | T. 16 N.

Creek

Surprise

BOUNDARY

NATIONAL FOREST

CLARK AND LEWIS

33 34 4 3 9 10

Cc Cx Wr Bs Gr Cb Bp Rd Ca Du Th Tm Cp Br Wo Sr Dx Jr Ss St Lr

(Joins sheet 68)

(Joins upper right)

0 ½ 1 Mile

Scale 1:20000

R. 10 E.

(Joins lower left)

SURVEY

SOIL

DETAILED

LIMIT

OF

LEWIS AND CLARK NATIONAL FOREST

16 15 21 22 28 27

LEWIS AND CLARK NATIONAL FOREST BOUNDARY

T. 15 N.

Creek

Wolf

Dry

Dx Lr Rd So St Sr Jr Br Wo Wr Bp Hu Cu Rf Jn

(Joins sheet 77)

0 5000 Feet

(Joins inset, sheet 85)

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 77

R. 10 E. | R. 11 E.

(Joins sheet 68)

77

N

T. 15 N.

LEWIS AND CLARK NATIONAL FOREST

BLACKTAIL HILLS

Creek

Wolf

Dry

13 14 17 18 19 20 23 24 25 26 29 30

(Joins sheet 76)

(Joins sheet 78)

(Joins sheet 85)

LEWIS AND CLARK NATIONAL FOREST

LIMIT OF DETAILED SOIL SURVEY

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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JUDITH BASIN AREA, MONTANA — SHEET NUMBER 78

78

(Joins sheet 69)

R. 11 E.

N

T. 15 N.

(Joins sheet 77)

(Joins sheet 79)

(Joins sheet 86)

Wolf Creek Rd

Running Rd

Willow Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 79

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R. 12 E.

T. 15 N.

(Joins sheet 70)

(Joins sheet 78)

(Joins sheet 80)

(Joins sheet 87)

79

N

Willow Creek

Gd Creek

Sage Creek

17 18 16 15 19 20 21 22 30 29 28 27

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 80

(80)

(Joins sheet 71)

R. 12 E. | R. 13 E.

N

T. 15 N.

(Joins sheet 79)

(Joins sheet 81)

(Joins sheet 88)

14 13 18 17

23 24 19 20

26 25 30 29

Sage Creek

Gr Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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R. 13 E.

(Joins sheet 72)

81

N

T. 15 N.

(Joins sheet 80)

(Joins sheet 82)

(Joins sheet 89)

16 15 14 13

21 22 23 24

28 27 26 25

Louse Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 82

82

(Joins sheet 73)

R. 14 E.

N

GREAT NORTHERN

CENTRAL MONTANA BRANCH EXPERIMENT STATION

Louse Creek

18 17 16 15

19 20 21 22

30 29 28 27

T. 15 N.

(Joins sheet 81)

(Joins sheet 83)

(Joins sheet 90)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 83

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Range, township, and section corners shown on this map are indefinite.

R. 14 E. | R. 15 E.

(Joins sheet 74)

83

N

T. 15 N.

(Joins sheet 82)

(Joins sheet 84)

(Joins sheet 91)

Moccasin

GREAT NORTHERN

87 20 789

GRAVEL PIT

14 13 18 17 23 24 19 20 26 25 30 29

Dm Dn Jm Jn Jv Jc Jd Jf Jt Jb Ub Ug Ua Gr Sk Sh Sy Gc Wn Bo SR

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 84

84

(Joins sheet 75)

R. 15 E.

N

T. 15 N.

FERGUS COUNTY

Judith River

16 15 14 13

21 22 23 24

28 27 26 25

(Joins sheet 83)

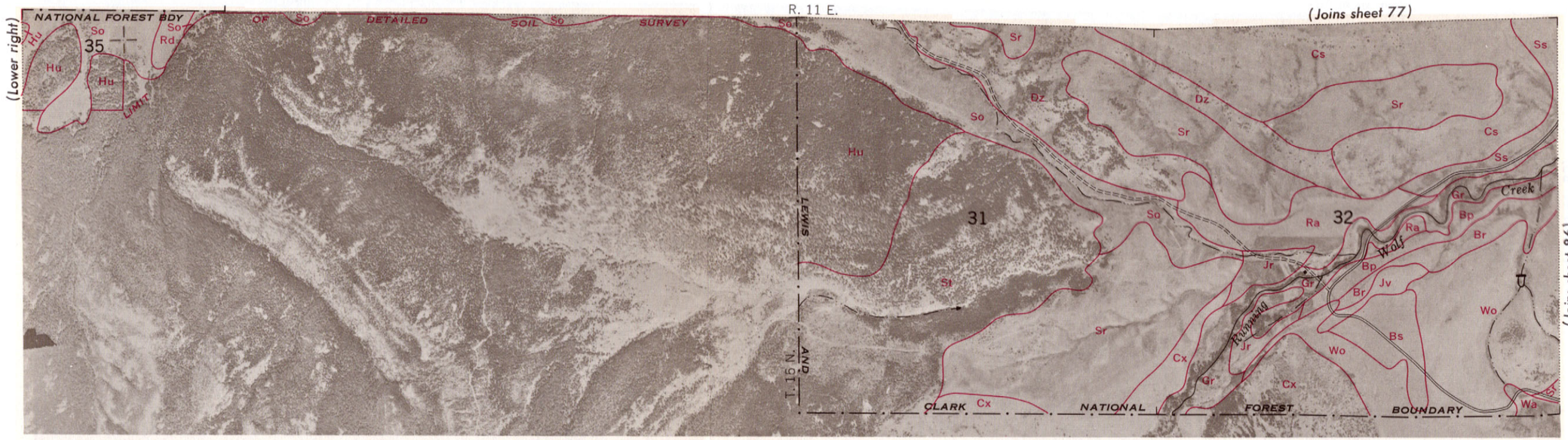
(Joins sheet 92)

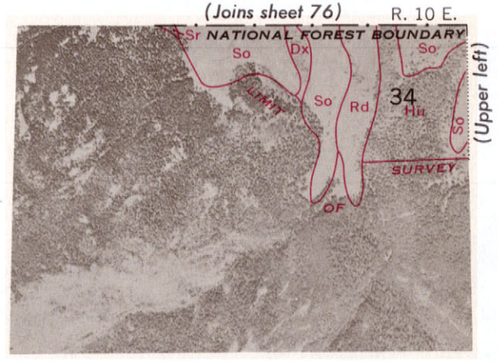
0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 85





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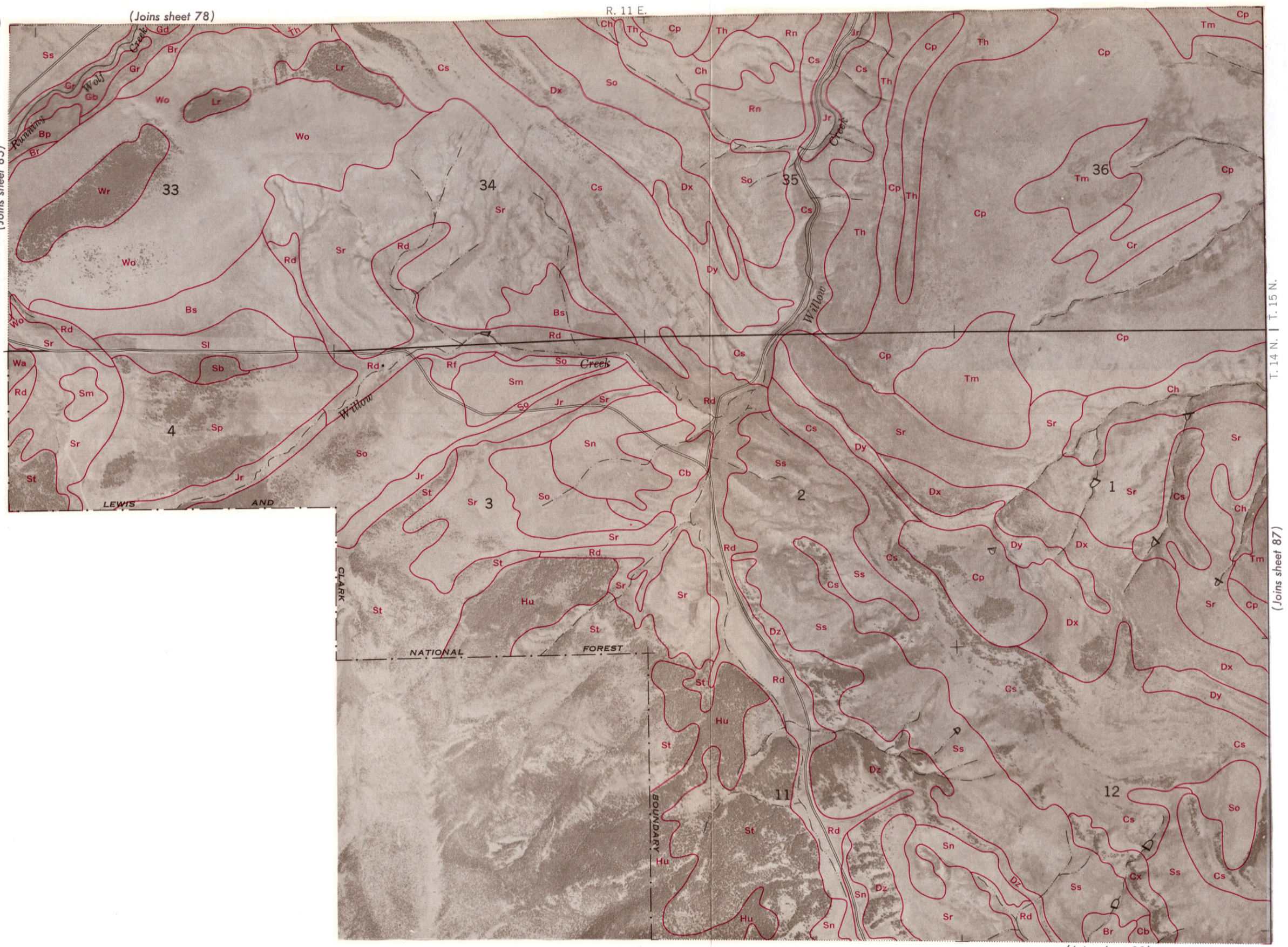
0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 86



JUDITH BASIN AREA, MONTANA — SHEET NUMBER 87

R. 12 E.

(Joins sheet 79)

87

N

T. 14 N. | T. 15 N.

(Joins sheet 86)

(Joins sheet 88)

(Joins sheet 94)

Sage Creek

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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JUDITH BASIN AREA, MONTANA — SHEET NUMBER 88

(88)

N

(Joins sheet 80)

R. 12 E. | R. 13 E.

T. 14 N. | T. 15 N.

(Joins sheet 87)

(Joins sheet 89)

(Joins sheet 95)

Sage Creek

Louse Creek

35 36 31 32

2 1 6 5

11 12 7 8

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 89

R. 13 E.

(Joins sheet 81)

89

N

T. 15 N.

T. 14 N.

(Joins sheet 88)

(Joins sheet 90)

(Joins sheet 96)

Louse Creek

33 34 35 36

4 3 2 1

9 10 11 12

Dm Dn Wf Jp Jm Po Ua Wc Wd Wa Dw Jn Jc Sv Dp Wn Ub Gr Mb Wb Sg Ga Jf Sd Sy Cp

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

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JUDITH BASIN AREA, MONTANA — SHEET NUMBER 90

90

(Joins sheet 82)

R. 14 E.

N

T. 14 N. | T. 15 N.

(Joins sheet 89)

(Joins sheet 91)

(Joins sheet 97)

Judith River

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 91

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 14 E. | R. 15 E.

T. 14 N. | T. 15 N.

(Joins sheet 83)

(Joins sheet 90)

(Joins sheet 92)

(Joins sheet 98)

91

N

Hobson

Judith River

GREAT NORTHERN

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 92

92

R. 15 E.

T. 14 N. | T. 15 N.

FERGUS COUNTY

N

(Joins sheet 84)

(Joins sheet 91)

(Joins sheet 99)

Judith River

Judith River

Ross Fork

GREAT NORTHERN

33 34 35 36

4 3 2 1

9 10 11 12

87 20 789

0 ½ 1 Mile Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 93

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Range, township, and section corners shown on this map are indefinite.

R. 11 E.

(Joins sheet 86)

93

N

T. 14 N.

NATIONAL FOREST BOUNDARY

CLARK AND LEWIS

Sage Creek

13 14 22 23 24 25 26 27

(Joins sheet 94)

(Joins sheet 100)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

94

N

(Joins sheet 87)

R. 12 E.

T. 14 N.

(Joins sheet 93)

(Joins sheet 95)

(Joins sheet 101)

Sage Creek

18 17 16 15

19 20 21 22

30 29 28 27

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 95

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

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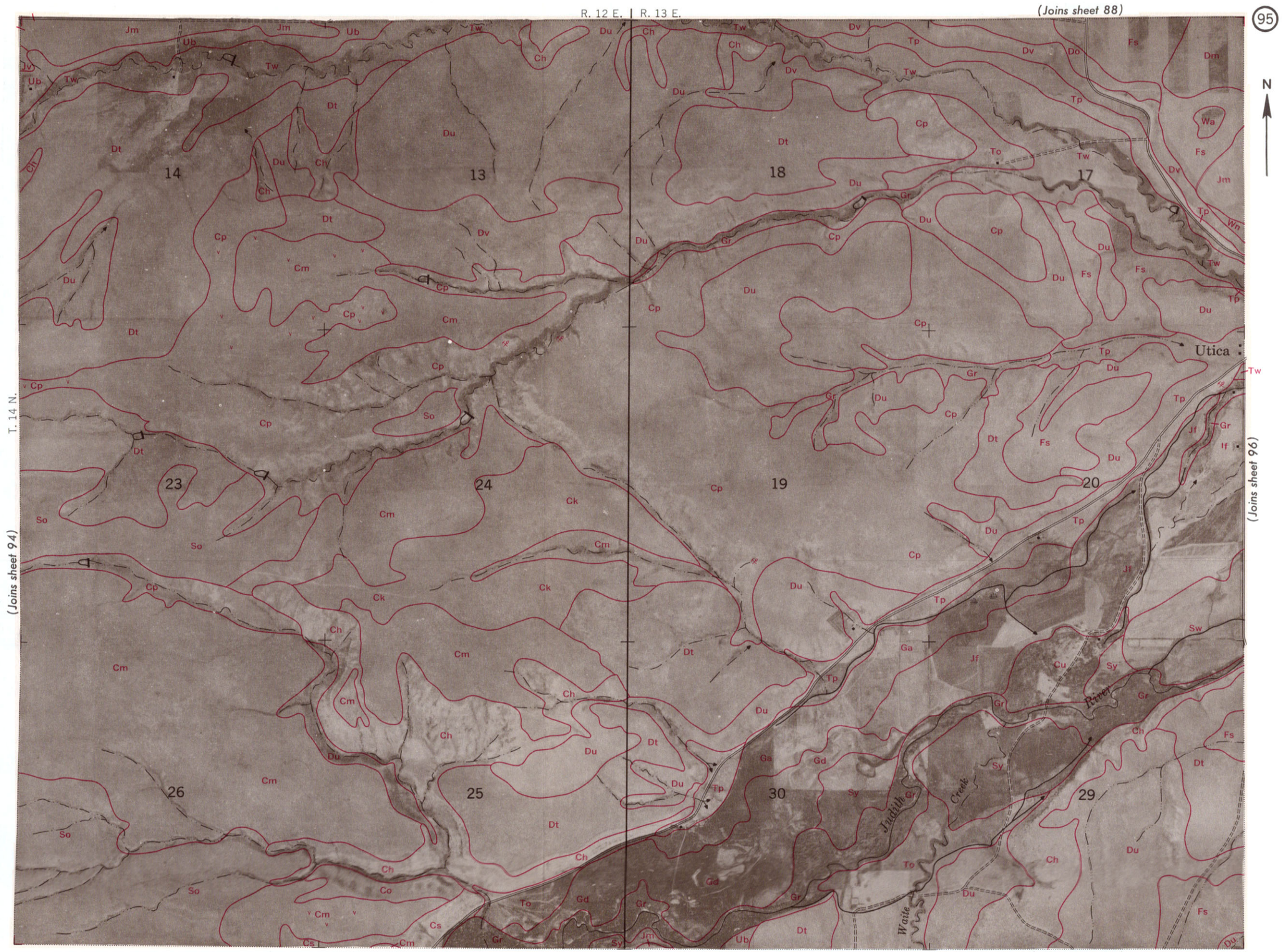

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 96

(96)

(Joins sheet 89)

R. 13 E.

N

Utica

Judith River

Antelope Creek

16 15 14 13

21 22 23 24

28 27 26 25

T. 14 N.

(Joins sheet 95)

(Joins sheet 97)

(Joins sheet 103)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 97

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service and the Forest Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.

R. 14 E.

(Joins sheet 90)

97

N

T. 14 N.

(Joins sheet 96)

(Joins sheet 98)

(Joins sheet 104)

Judith River

Antelope Creek

GRAVEL PIT

GRAVEL PIT

ACKLEY LAKE

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

JUDITH BASIN AREA, MONTANA — SHEET NUMBER 98

98

(Joins sheet 91)

R. 14 E. | R. 15 E.

N

T. 14 N.

GREAT NORTHERN

Coulee

Hauck

(Joins sheet 97)

(Joins sheet 99)

(Joins sheet 105)

14 13 18 17

23 24 19 20

26 25 30 29

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

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JUDITH BASIN AREA, MONTANA

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Dual
- Good motor
- Poor motor
- Trail

Highway markers

- National Interstate
- U. S.
- State

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

- Buildings
- School
- Church
- Station

- Mines and Quarries
- Mine dump
- Pits, gravel or other
- Power lines
- Pipe lines
- Cemeteries
- Dams
- Levees
- Tanks
- Oil wells
- Windmill

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams

- Perennial
- Intermittent, unclass.
- Crossable with tillage implements
- Not crossable with tillage implements

- Canals and ditches — CANAL / DITCH

Lakes and ponds

- Perennial
- Intermittent

- Wells — flowing
- Springs
- Marsh
- Wet spot

RELIEF

Escarpments

- Bedrock
- Other

- Prominent peaks

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies
- Saline spot